Saskatchewan
Highways and
Transportation

Engineering Division
1855 Victoria Avenue
Regina, Canada
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EFFECTIVENESS

OF PASSING LANES

ON HIGHWAY NO. 1

Monique Kealey
Jon Wyatt, P.Eng
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Design & Traffic Safety Branch
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90-05330/

EXECUTIVE SUMMARY

The construction of auxiliary lanes to permit unhindered passing of slower moving vehicles is an inexpensive and cost effective means to improve level of service on some two lane highways.

Trans Canada Highway No. 1 from Grenfell to Indian Head is a two lane highway with 2.0 metre shoulders. Twenty percent of the traffic are commercial vehicles. The current design hour volume (DHV) is 400 vehicles per hour and the highway is operating at a Level of Service B. Passing opportunities are available for 65% of the highway.

In 1989 the Department initiated a study of the operational effects of the passing lanes to determine whether passing lanes are effective at the lower traffic volumes in Saskatchewan's rural environment. An evaluation of the public perception of the passing lanes was also required. The third objective was to determine whether there were any difficulties at the merge tapers.

The platooning in the passing lane drops by 35%, slightly less than the estimated 50% reduction. The net percent reduction achieved over the ten kilometre effective length is 14.5% for 300 vehicles per hour and 20% for 500 vehicles per hour. For the passing lanes heading towards the nearby towns the effective length is restrained to five kilometres and similar reductions in platooning are realized.

The achieved overtaking rate for the passing lane sections increased by twenty percent. Based on the Achieved/Desired Overtaking Ratio Criteria for measuring Level of Service proposed by Morrall the highway was operating at a low Level of Service A before the passing lanes were constructed, and are now operating at a high Level of Service A with the passing lanes.

Sixty percent of the respondents of a passing lane questionnaire rated the highway as safe. The passing opportunities are perceived as fair by 45% of the respondents, and 62% of the respondents indicated they often spend time following slower vehicles. Half of these are frustrated while doing so. Respondents suggested that signing at the merge ends could be improved by erecting signs on both sides of the road to make them more visible. Twenty five percent of the respondents indicated problems with the actual merge maneuver. Fifteen percent of the respondents made positive comments regarding passing lanes. Twenty-five percent suggested four laning.

Traffic was observed using a video cassette recorder to identify whether any operational problems associated with the passing lane merge ends exists. Traffic conflicts occurred for 3.1% of all vehicles, mostly due to the merging vehicle causing a conflict for other vehicles. No motor vehicle accidents at the passing lanes have been reported in the eighteen months of their operation.

ACKNOWLEDGEMENTS

The authors wish to acknowledge Dr. John Morrall,Professor of Civil Engineering, University of Calgary, for his assistance with planning the passing lane study and with analysing the data. Special thanks to Don Sudom for the video taping and very detailed analysis of the merge tapers. Mickey Lenzen and Barry Andrie are commended for the thorough data collection on which the study so heavily relied upon.

Ray Gerbrandt, Grant Godwin and Greg Gilkes, members of The Steering Committee are also acknowledged for their input and direction throughout the project.

Thank you to Technical Research Branch for providing the funding to complete the project.

This document reports on the findings of a technical research project to gain a better understanding about the operation of passing lanes. The report does not represent official Department of Highways and Transportation policy.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Background 1
1.2 Study Design 4
2.0 SYSTEM OPERATION 5
2.1 Platoon Leaders 5
2.2 Platooning Versus Traffic Volume 8
2.3 TRARR Simulation 8
2.4 Change in Speed by Location 12
2.5 Conclusion 13
3.0 PASSING LANE OPERATION 14
3.1 Overtaking Rates 14
3.2 Lane Behavior 15
3.3 Conclusion 15
4.0 QUESTIONNAIRE 16
4.1 Type of Vehicle 16
4.2 Passing Opportunities 17
4.3 Amount Of Time Spent Following 18
4.4 Quality Of Time Spent Following 19
4.5 Reasons For Difficulty Passing 19
4.6 Safety Of Highways 21
4.7 Helpfulness Of Signs 21
4.8 Length Of Passing Lanes 23
4.9 Do Vehicles Keep Right 23
4.10 Merging Problems 26
4.11 Additional Comments or Suggestions 26
4.12 Other Feedback 26
4.13 Conclusion 26
5.0 OPERATIONAL SAFETY OF THE MERGE ENDS 27
5.1 Traffic Conflict Definitions 27
5.2 Traffic Conflict Data 27
5.3 Classifications 27
5.4 Merging Problems 29
5.5 Conclusion 30
6.0 SUMMARY OF CONCLUSIONS 31
6.1 Further Research Required 32

REFERENCES
APPENDIX A - Data Collection and Accuracy
APPENDIX B - Data Summaries
APPENDIX C - General Highway Characteristics
APPENDIX D - Passing Lane Questionnaire And Responses
APPENDIX E - Traffic Conflict Definitions

FIGURES AND TABLES

TABLES

1.1 Passing Lane Locations, Highway No. 1 4
2.1 Vehicle Classification On Highway No. 1 5
2.2 Average Speeds on Provincial Highways 6
3.1 Overtaking Rates In The Passing Lanes 14
3.2 Actual Platooning In The Passing Lanes 15
4.1 Respondents' Vehicles Versus Actual Vehicles On Hwy No. 1 . . 17

FIGURES

1.1 Passing Lanes in Saskatchewan 2
1.2 Passing Opportunities on Highway No. 1 3
2.1 % of Traffic Stream by Vehicle Type 6
2.2 Location of Classification Sites 6
2.3 % of Class Leading Platoons 7
2.4 Platooning Versus Traffic Volume 8
2.5 % Platooned Along Passing Lane Section 10
2.6 % Platooned Along Passing Lane Section 11
2.7 Average Speed By Location 13
4.1 Question 1 - Type of Vehicle 16
4.2 Question 2 - Passing Opportunities 17
4.3 Time Spent Following 18
4.4 Passing Opportunities vs Time Following 19
4.5 Quality of time Spent Following 20
4.6 Quality of Time by Amount of Time 20
4.7 Question 4 - Inability to Pass 21
4.8 Safety of Highway 22
4.9 Helpfulness of Signs 22
4.10 Length of Passing Lane 23
4.11 Question Responses 24
5.1 Traffic Conflict and Erratic Maneuver Types Evaluated 28
5.2 % of Conflict Vehicles Compared to % of Total Vehicles 29

1.0 INTRODUCTION

1.1 Background

The construction of auxiliary lanes to permit guaranteed passing of slower moving vehicles is an inexpensive means to improve level of service on some two lane highways.

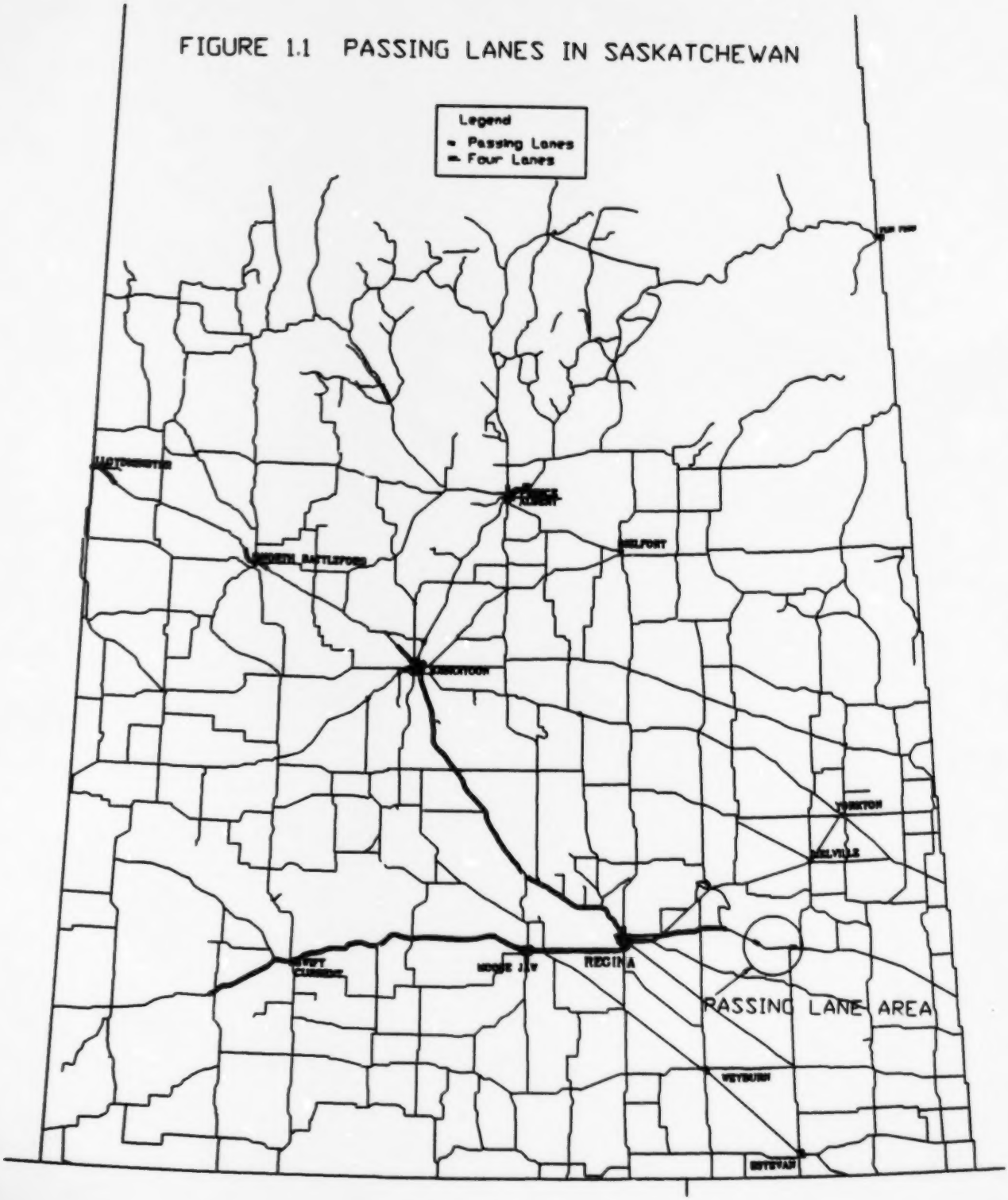
In 1987 a study by Saskatchewan Highways and Transportation identified potential locations for passing lanes on Saskatchewan's highways using theoretical calculations of net passing opportunities to give priority to each of the projects. Subsequently two sets of passing lanes were constructed on Highway No. 1 and opened in October, 1988.

Trans Canada Highway No. 1 from Grenfell to Indian Head is a two lane highway with a 2.0 metre paved shoulder. Twenty percent of the traffic are commercial vehicles. The 1988 AADT ranges from 2400 to 2950 along this section. The current design hour volume (DHV) is 400 vehicles per hour (veh/hr). This is estimated to increase to 500 vehicles per hour by the year 2005. Passing opportunities due to roadway geometry are available for 65% of the highway. Figure 1.1 illustrates the location of this highway in Saskatchewan.

The experience along this section of highway is similar to many jurisdictions in that traffic volumes are high enough to restrict passing but too low to justify upgrading to four-lanes. Analysis of Level of Service that was completed by Dr. John Morrall at the University of Calgary indicates that this highway is operating at a level of service B.

One set of passing lanes is west of Grenfell and the other is west of Wolseley. The exact locations of the passing lanes are listed in Table 1.1. Figure 1.2 illustrates the passing lane locations and the passing opportunities on Highway No. 1. The main advantage of the passing lanes is the transition from passing opportunities hindered by opposing traffic, to assured passing opportunities. A side by side configuration was utilized rather than a staggered configuration because the geometric passing opportunities are good and staggering would reduce overall passing by 50%.

FIGURE 1.1 PASSING LANES IN SASKATCHEWAN



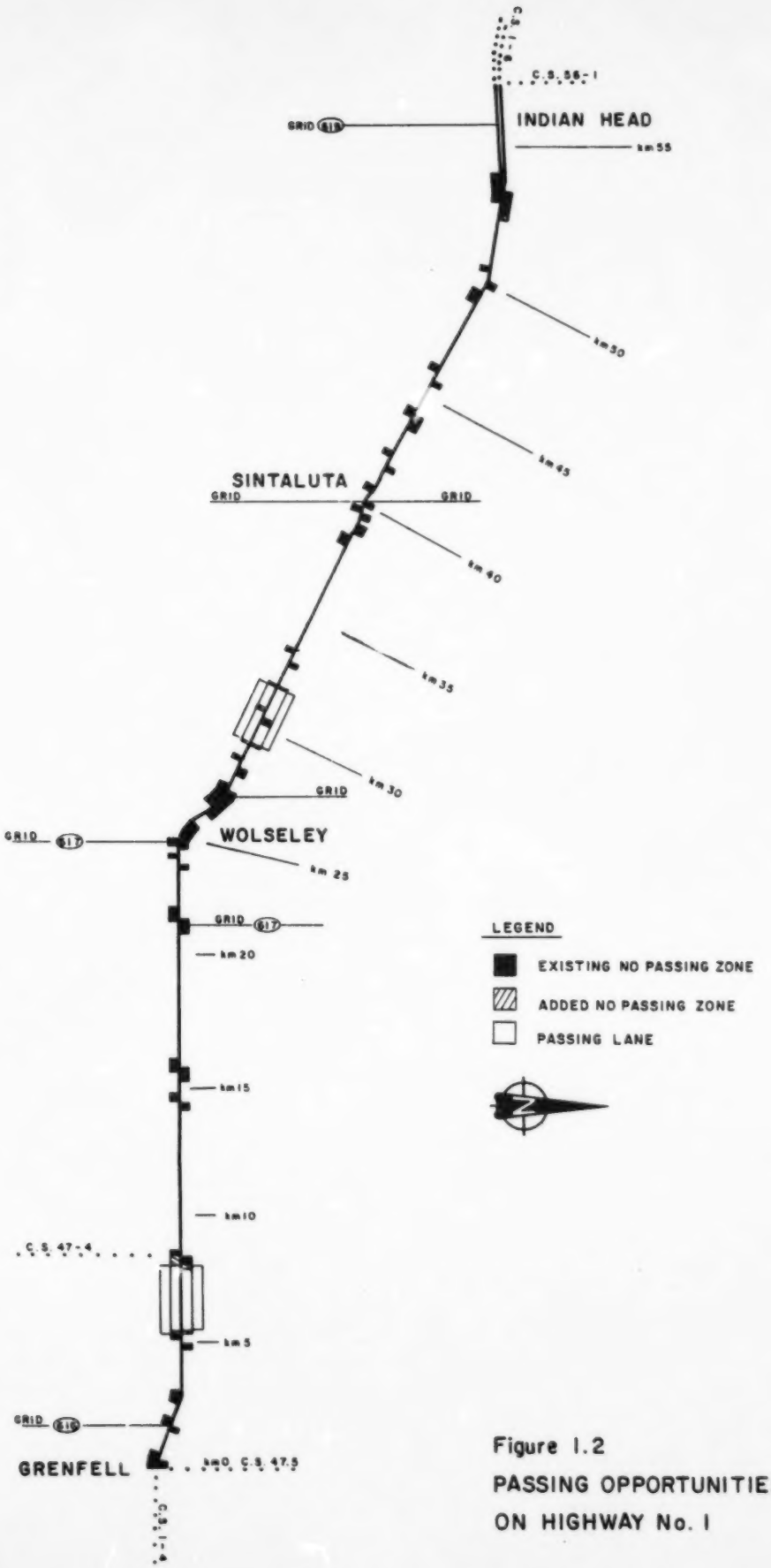


Figure 1.2
PASSING OPPORTUNITIES
ON HIGHWAY No. 1

TABLE 1.1 Passing Lane Locations, Highway No. 1

	From km	To km
Westbound Passing Lanes	5.6	7.5
	30.0	32.1
Eastbound Passing Lanes	7.5	5.4
	31.9	29.8

The passing lane signing and pavement marking corresponds with RTAC's standard in the Uniform Traffic Control Devices for Canada Manual. The merge end tapers of the passing lanes are 200 metres long. The lane width and shoulder width are 3.7 m and 2.0 m respectively.

1.2) Study Design

The Department initiated a study in 1989, of the operational effects of passing lanes to determine whether passing lanes are cost effective at the lower traffic volumes in Saskatchewan's rural environment. The primary objective was to determine the effectiveness of the passing lanes by measuring the length of highway that provides decreased platooning for peak volumes. An evaluation of the public perception of the passing lanes in terms of operational problems and perceived improvements to the highway was also required. The third objective was to determine the operational safety of the merge ends and to identify existing problems.

The study utilized traffic statistics recorders, visual observations, questionnaires and a video camera to collect the necessary data for a thorough evaluation. Dr. John Morrall was commissioned for consultation during the design of the final work plan to select traffic counter locations and provide guidance in the development of the questionnaire. Over a two week period in July, weekday traffic stream characteristics were collected for 36 to 48 hour periods, supplemented by various visual observations for shorter time periods. The video camera was utilized intermittently throughout the two weeks and the questionnaire was distributed in late July.

2.0 SYSTEM OPERATION

2.1 Platoon Leaders

A platoon is defined as two or more cars with headways between each other of less than 5 seconds. Vehicle classifications were collected throughout the system for all vehicles and for platoon leaders. The classification light vehicles includes private vehicles, half-tons and panel vans. Recreational vehicles are any self propelled recreational vehicles and any vehicles pulling recreational trailers. Heavy vehicles include all commercial trucks with two or more axles. Table 2.1 summarizes the platoon leader characteristics by vehicle classification.

Table 2.1 Vehicle Classifications on Highway No. 1

VEHICLE CLASSIFICATION	Traffic Stream Total	%	Platoon Leaders Total	%	% of Class	Avg. Size
Light Vehicles	636	77.7%	97	67.8%	15.3%	2.5
Recreational	73	8.9%	19	13.3%	26.0%	2.1
Heavy Vehicles	110	13.4%	27	18.9%	24.5%	2.5

The size of platoon versus platoon leader classification in Table 2.1 indicates that platoon size is not a function of classification. Recreational vehicles lead slightly smaller platoons than the other classifications.

Figure 2.1 illustrates the above values in proportions of each vehicle type leading platoons. It is clear that a larger proportion of heavy vehicles and recreational vehicles lead platoons relative to the number travelling on this section of highway. This is expected because average speeds of light vehicles are higher than for recreational and heavy vehicles.

The percentage of each class that are platoon leaders is a function of average vehicle speed, and available passing opportunities. Platoon leaders observed are not necessarily the slowest moving vehicles if passing opportunities have been good and the slowest vehicle has just been passed. Table 2.2 provides the speed study data for provincial highways similar to the study section.

Figure 2.1
% of Traffic Stream by Vehicle Type

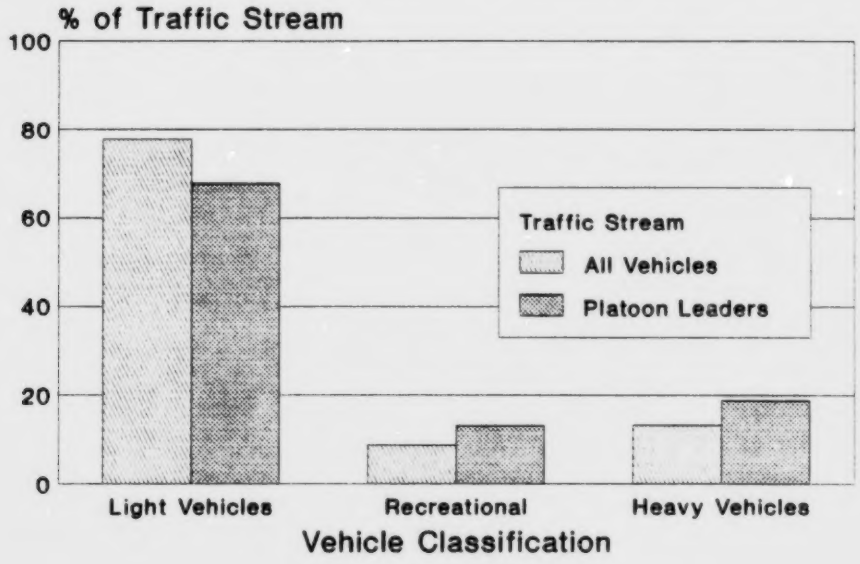


Table 2.2 Average Speeds on Provincial Highways[1]

Classification	Average Speed (km/h)	Standard Deviation (km/h)
Light Vehicles	103.1	7.4
Recreational	90.7	7.5
Heavy Vehicles	95.6	8.7

Figure 2.2 illustrates the relative position of the study sites. Two of the classification study sites are located near one of the westbound passing lanes. Site A is 50 metres in advance of the passing lanes and site B is 2.5 kilometres downstream of the end of the passing lanes. Site C is 1.7 kilometres downstream of the passing lanes in the eastbound direction and is two kilometres upstream from Grenfell.

Figure 2.2 Location of Classification Sites

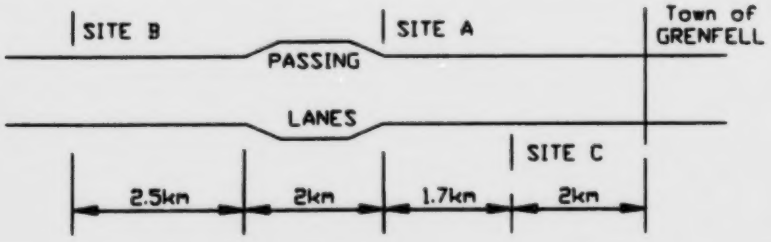
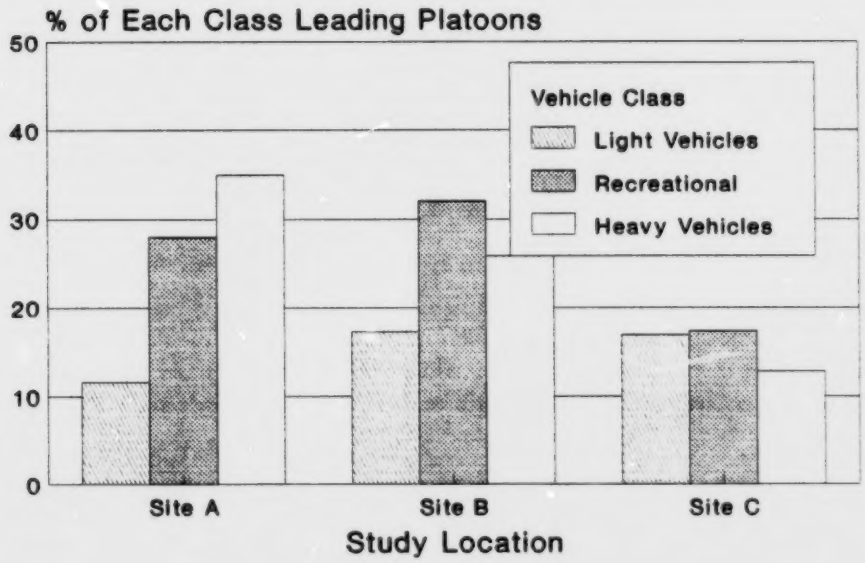


Figure 2.3 illustrates the percent of each class that are leading platoons for all three locations. Significantly more heavy vehicles are leading platoons just before the passing lanes at Site A in comparison with several kilometres downstream of the passing lanes at Site B. The two locations have similar platoon sizes which are 2.56 and 2.55 respectively.

Figure 2.3
% of Class Leading Platoons



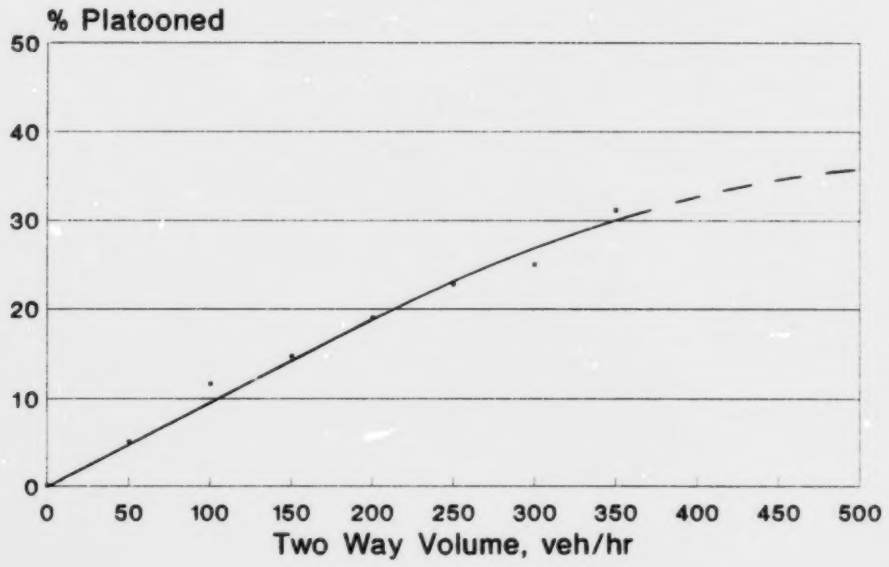
Site B has more recreational and heavy vehicles that are platoon leaders than at Site C. One possibility is that even ten kilometres after a town which elicits increased turning movements, the traffic has not yet sorted itself out. The percent platooned at each location supports this hypothesis. For the same traffic volume 29.2% of the vehicles are platooned at Site B compared with 20.1% for Site C.

The platoon size at Site C is 2.26, which is eleven percent smaller than the others. Platoon size does not seem to be a function of location relative to the passing lanes.

2.2 Platooning versus Traffic Volume

Platooning versus traffic volume over twenty-four hour periods was plotted for several locations along one section to determine a relationship between traffic volume and number of vehicles platooned. Figure 2.4 illustrates the average trend for Highway No. 1 with passing lanes. At lower volumes the relationship is linear and starts to level off at 250 vehicles per hour. Percent platooned is approximately ten percent greater at 500 vehicles per hour than for 300 vehicles per hour.

Figure 2.4
Platooning Versus Traffic Volume



2.3 TRARR Simulation

TRARR is a mathematical model for simulating traffic on two-lane rural roads that was developed by the Australian Road Research Board. It can be used to predict changes in traffic operations due to changes in roadway characteristics, such as passing lanes and turning bays, passing opportunities, and vehicle mix.

Initially the model was run to calibrate it to actual traffic operations data on Highway No. 1. The model was accurate for three of the four passing lanes. For the eastbound passing lanes near Wolseley the model overestimates platooning by 5%. Additional documentation on the accuracy of the model for this scenario is provided in Appendix A.

The percent platooned at the start of the passing lane is an input variable; then TRARR determines the platooning at other positions along the highway. Traffic operations without the passing lanes were simulated assuming the same input platooning values as for the simulation with passing lanes.

TRARR was used to determine the effect of passing lanes along the highway sections affeceted. The westbound section illustrated in Figure 2.5 experiences a reduction in platooning for most of the 10.3 kilometres downstream of the passing lanes, whereas the eastbound section illustrated in Figure 2.6 only has an effective length of 5.4 kilometres due to the proximity of the Town of Grenfell downstream.

Harwood estimates that the percentage of vehicles platooned stabilizes within the passing lane at about half the platooning of the two-lane roadway (2). Figures 2.5 and 2.6 illustrate that for these passing lanes the platooning in the passing lane drops by 35% where the passing lane is situated, slightly less than estimated.

The net percent platooned reduction achieved for 300 vehicles per hour over the ten kilometre effective length is 14.5%; from 26.2% platooned to 22.4% platooned. Harwood estimates percent time delay would change from 33% down to 17% for a similar passing lane length and effective length. His values were derived for non-ideal conditions of terrain, no passing zones and traffic composition (2). Harwood's values are higher since these passing lanes have moderately good passing opportunities due to level terrain.

At 500 vehicles per hour, the number of vehicles platooned is estimated to decrease by 20% over the effective length based on the simulated results illustrated in Figure 2.5.

FIGURE 2.5
% Platooned Along Passing Lane Section

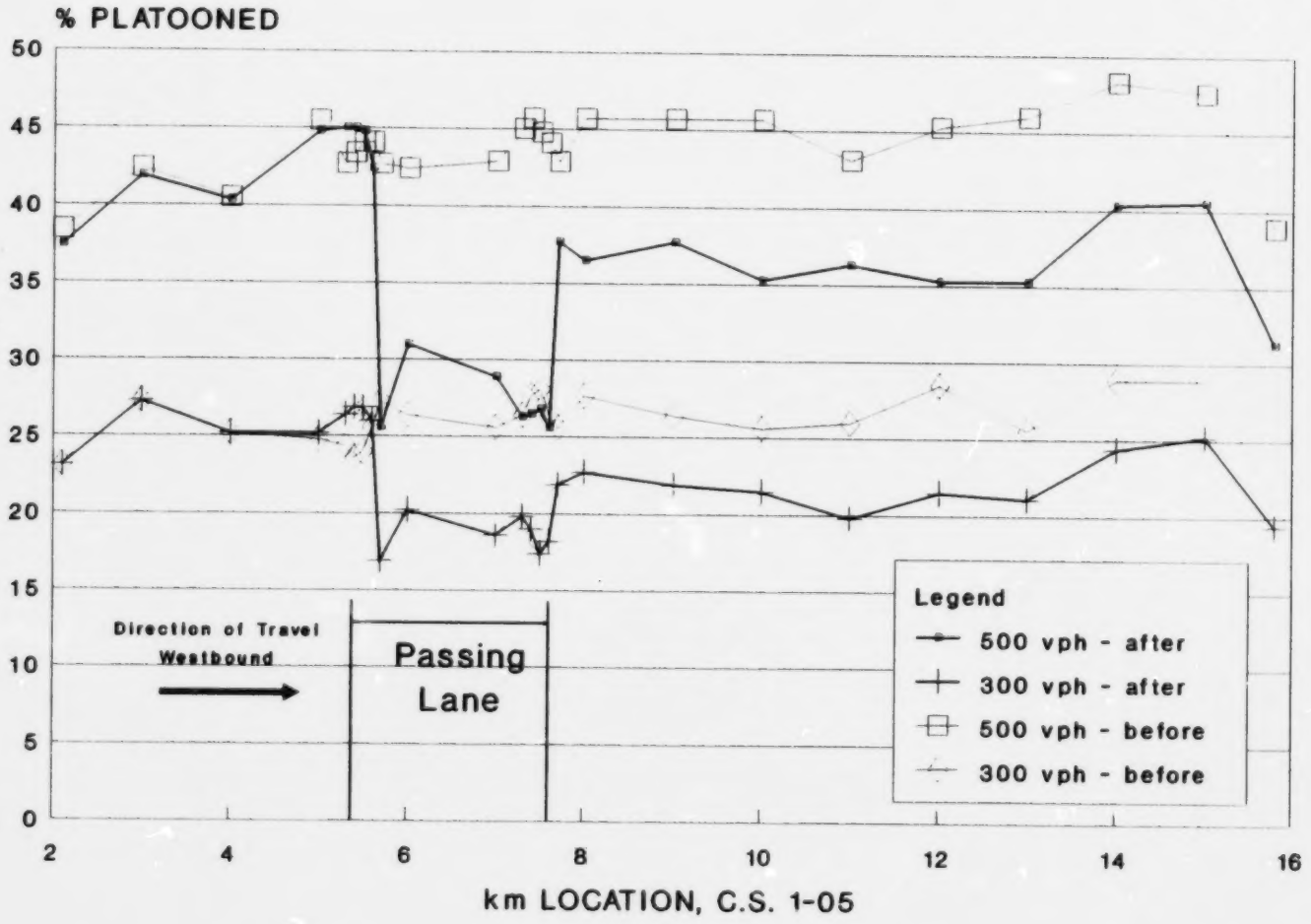
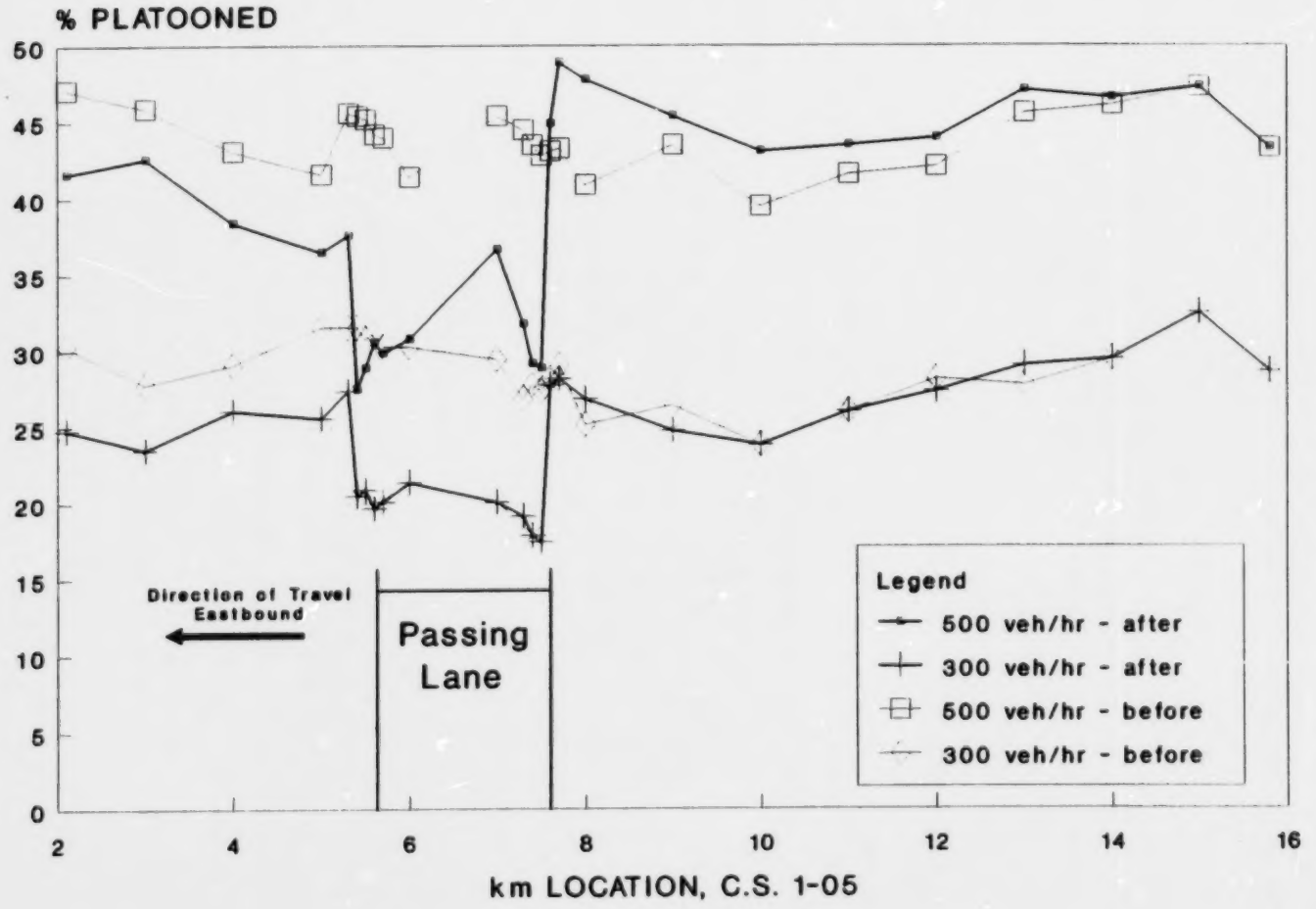


FIGURE 2.6
% Platooned Along Passing Lane Section



The passing lane section that has a shorter effective length has a similar percent reduction in platooning to the other section. As a means of indicating that there is more benefit for the westbound passing lane because the effective length is longer, the change in area on the graph may be a good variable to compare. The effective area in Figure 2.5 is 117 vehicle kilometres platooned whereas the eastbound area is decreased by 73 vehicle kilometres platooned for 300 vehicles per hour.

Research by Morrall and Wong indicates that percent time delay is not a good surrogate measure for overtakings. Although the use of passing lanes results in a decrease in percent time following it is less than the increase in mobility in terms of overtakings (3). The achieved overtaking rate for the passing lane section in Figure 2.5 increases from 0.056 vehicles overtaken per vehicle per kilometre to 0.066, an increase of 17.9%.

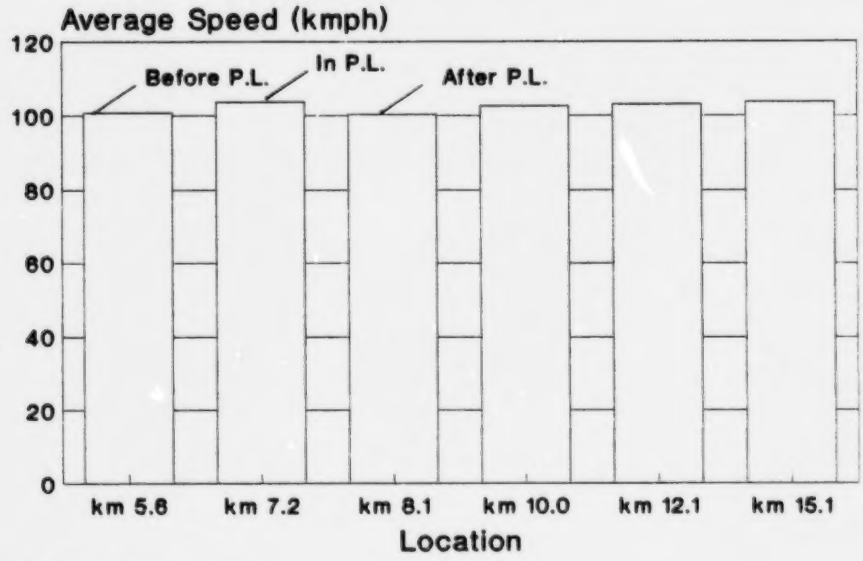
The simulation model was used to estimate the desired overtaking rate assuming that the whole section has four lanes and passing permitted. An overtaking rate of 0.080 vehicles overtaken per vehicle per kilometre and 14.0% platooned are desired for a traffic volume of 300 vehicles per hour. Based on the Achieved/Desired Overtaking Ratio Criteria for measuring Level of Service proposed by Morrall [3] the highway was operating at a low Level of Service A before the passing lanes were constructed, and are now operating at a high Level of Service A with the passing lanes.

Level of service calculations in the 1985 Highway Capacity Manual do not account for the change in LOS due to passing lanes. Therefore, current standards for Level of Service cannot be utilized to determine the effectiveness of passing lanes on the highway in question.

2.4 Change in Speed by Location

The Traffic statistics recorders automatically collected vehicle speed for two sections of the highway. Figure 2.7 illustrates the change in average speed along the westbound section of highway west of Grenfell. There is no significant change in speed where the passing lanes are located.

Figure 2.7
Average Speed by Location



10:00 to 16:00, July 11, 1989

2.5 Conclusion

A larger proportion of heavy vehicles and recreational vehicles lead platoons relative to the number travelling on this section of highway. Platoon size is not a function of location relative to the passing lanes nor of platoon leader classification.

The platooning in the passing lane drops by 35%, less than the estimated 50% reduction. The net percent reduction achieved over the ten kilometre effective length is 14.5% for 300 vehicles per hour and 20% for 500 vehicles per hour. For the passing lanes heading towards the towns the effective length is restrained to five kilometres and similar reductions in platooning are realized. The effectiveness for 300 vehicles per hour can be appreciated many times throughout the year since the DHV is 400 vehicles per hour.

3.0 PASSING LANE OPERATION

3.1 Overtaking Rates

Two observers recorded the overtaking rates along the passing lanes for two hour periods. Each observer could see about a 450 metre section. At the west passing lanes they observed eastbound traffic on the last half of the passing lane section, and at the east passing lanes eastbound traffic on the first half of the passing lane traffic was observed. Table 3.1 summarizes the overtaking rates throughout the passing lanes.

Table 3.1 Overtaking Rates in the Passing Lanes

		% Passing	% Not Keeping Right	Passings Per Vehicle Per Kilometre
East Lanes	First Quarter	23.2	3.2	0.514
	Second Quarter	17.5	4.8	0.388
West Lanes	Third Quarter	11.0	9.4	0.245
	Fourth Quarter	10.7	11.7	0.238

More vehicles passed at the beginning of the passing lane which is expected of drivers who waited to pass knowing that the upcoming passing lanes would provide an assured passing opportunity. Based on the above information, shorter passing lanes located more frequently would be more effective than two kilometre passing lanes spaced twenty kilometres apart. The more common strategy is to begin with widely spaced lanes then insert lanes at the mid-way points as volumes increase and budgets permit.

The number of vehicles not keeping right was greater towards the end of the passing lanes. Vehicles would complete a passing maneuver and not move back to the right lane, essentially shortening the effective length of the passing lanes if a third vehicle in the initial platoon is trying to pass the vehicle in the left lane.

3.2 Lane Behaviour

The lane behavior and the vehicle platooning 400 metres into the passing lanes is provided in Table 3.2. The results illustrate the immediate effectiveness that the passing lanes have on releasing platooned vehicles.

Table 3.2 Actual Platooning in the Passing Lanes

	Apparent (Both Lanes Combined)	Right Lane	Left Lane
% Platooned	32.8%	20.3%	14.8%
Average Size of Platoon	2.41	2.32	2.19
No. of Platoons	64	34	7

3.3 Conclusion

More vehicles passed at the beginning of the passing lane which is expected of drivers who waited to pass knowing that the upcoming passing lanes would provide an assured passing opportunity. Ninety-five percent of the drivers use the passing lane properly by moving to the right. The number of vehicles not keeping right was greater towards the end of the passing lanes.

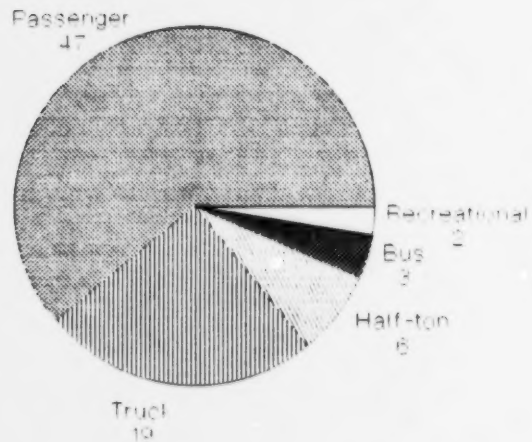
4. QUESTIONNAIRE

In July of 1989, 300 questionnaires were distributed to the public through local town offices, rural municipality offices, RCMP detachments, the Tourist Information Booths at Fleming and in Regina, the Weight Scale on Highway No. 1 and to several trucking companies. Seventy seven responses were received. The purpose of the questionnaire was to determine a typical driver's perception of the passing lane operation. A summary of the responses is provided in this section.

4.1 Type of Vehicle

Figure 4.1 illustrates the type of vehicle each of the respondents usually drives. The truck drivers indicated the number of axles of their vehicle, 90% of which were 5 or more axles.

Figure 4.1
Question 1 - Type of Vehicle



The percentage of vehicle types is compared with actual vehicle classifications travelling on this highway in Table 4.1. Commercial vehicles were well represented in the study while recreational vehicles were poorly

sampled. The extent of the passenger vehicles surveyed is typical of local traffic and not long distance commuter traffic.

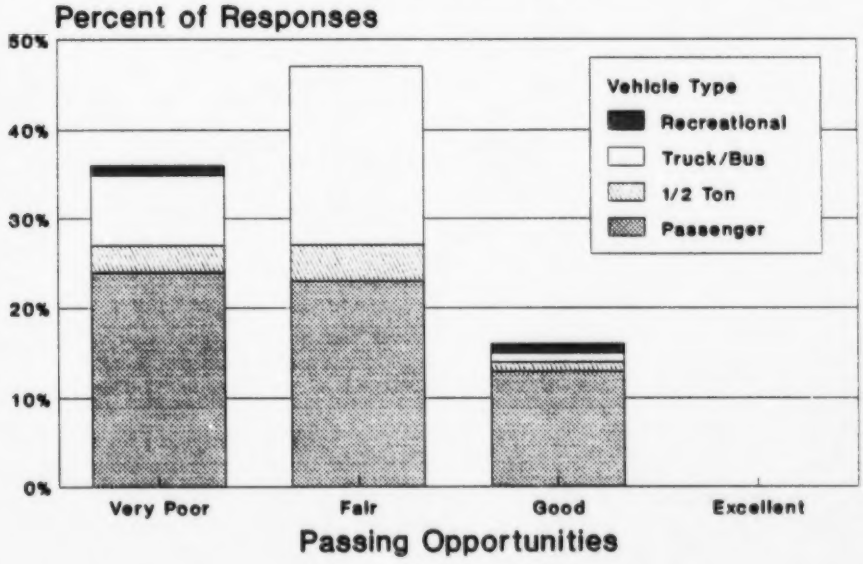
Table 4.1 Respondents' Vehicles Versus Actual Vehicles on Hwy No. 1

Vehicle Classification	Questionnaire Respondents	Actual Highway Classification
Light Vehicles	68.8%	77.6%
Truck/Bus	28.6%	13.4%
Recreational	2.6%	9.0%

4.2 Passing Opportunities

When asked in Question 2 to rate the passing opportunities along the section of highway, 47% of the respondents rated them fair. Figure 4.2 illustrates how the respondents of each vehicle type rated the passing opportunities. More truck drivers rated the opportunities fair than very poor. These drivers would be more familiar with many highways in the province which have higher traffic volumes and poorer passing opportunities than Highway No. 1 under study.

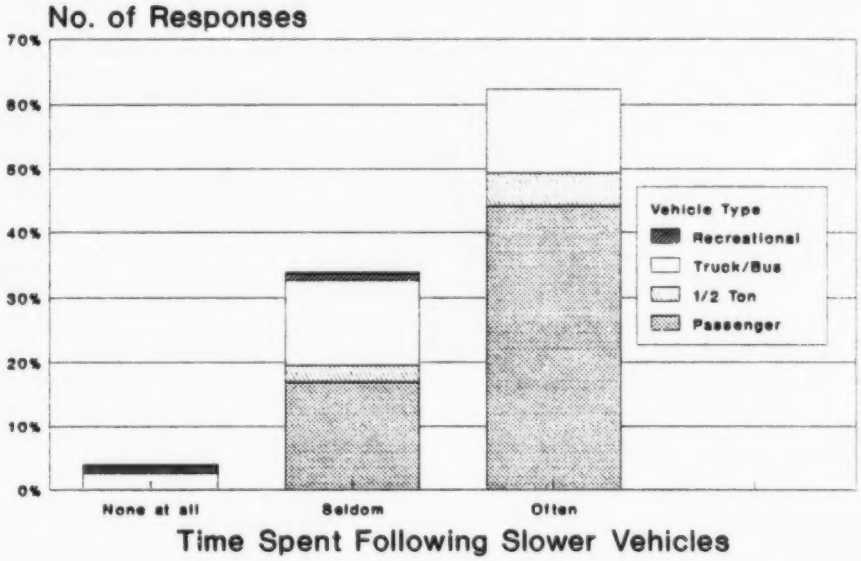
Figure 4.2
Question 2 - Passing Opportunities



4.3 Amount of Time Spent Following

Question 3 was asked to determine if respondents were consistent in each one's opinion of the highway's passing opportunities. They were asked to indicate the amount of time spent following, which is summarized in Figure 4.3. Sixty two percent of the respondents often follow slow moving vehicles which is greater than the number of respondents that indicated passing opportunities are very poor in Figure 4.2.

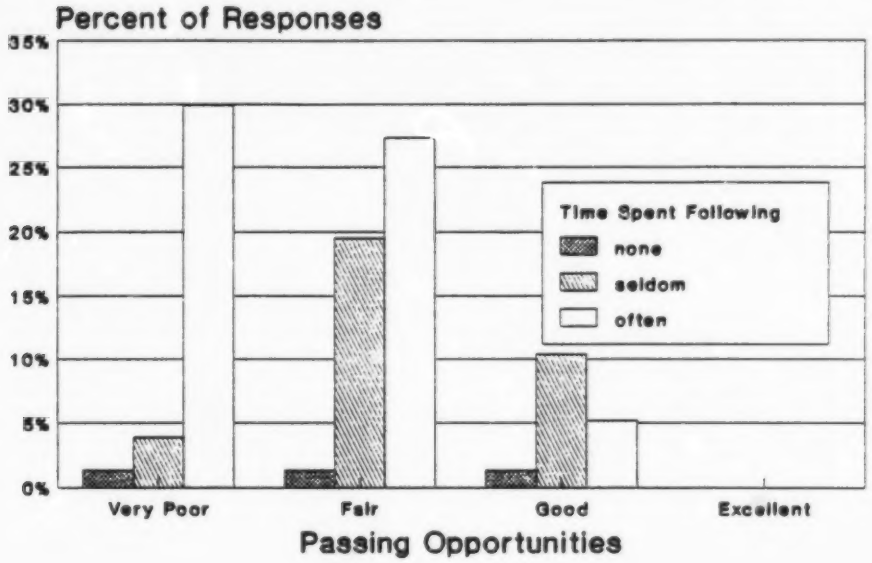
Figure 4.3
Time Spent Following



A larger portion of light vehicles, 72% often follow slower moving vehicles whereas only half of the trucks often follow slow vehicles. This is compatible with the higher average speed of passenger vehicles than trucks on the highway.

Figure 4.4 illustrates that those who perceive very poor passing opportunities are the same respondents who indicated they often follow slower moving vehicles. Those who rated fair and good passing opportunities may be willing to accept the fact that they follow slower moving vehicles seldom or often. The responses to question 5 will provide a clearer indication of this.

Figure 4.4
Passing Opportunities vs Time Following



4.4 Quality Of Time Spent Following

Question 5 asked the respondents to indicate which option was most typical of the time spent following vehicles. Figure 4.5 illustrates 40% of the people were impatient and 31% were frustrated to some extent. Figure 4.6 illustrates there is some acceptance to follow slower moving vehicles by those who often follow slower moving vehicles.

4.5 Reasons For Difficulty Passing

Question 4 asked the respondents to rank the three causes for inability to pass. Many respondents only checked off the main reason for difficulty passing rather than ranking the reasons. Figure 4.7 illustrates that a clear majority indicated "too many on-coming vehicles" is the primary reason for inability to pass. Next was "too many slow vehicles", and "a limited number of highway sections marked for passing" is close behind. Once again the public perception parallels actual fact. Approximately 35% of the highway section has "no passing" sections.

Figure 4.5
Quality of Time Spent Following

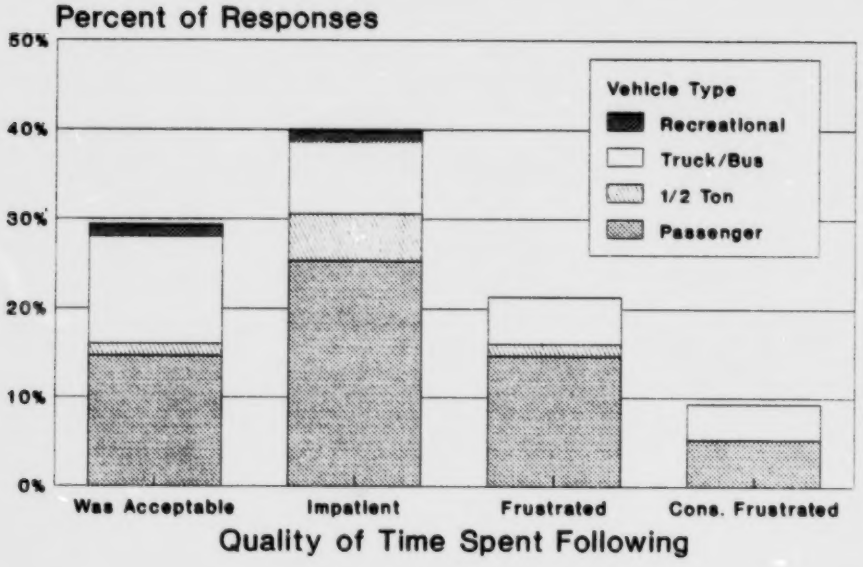
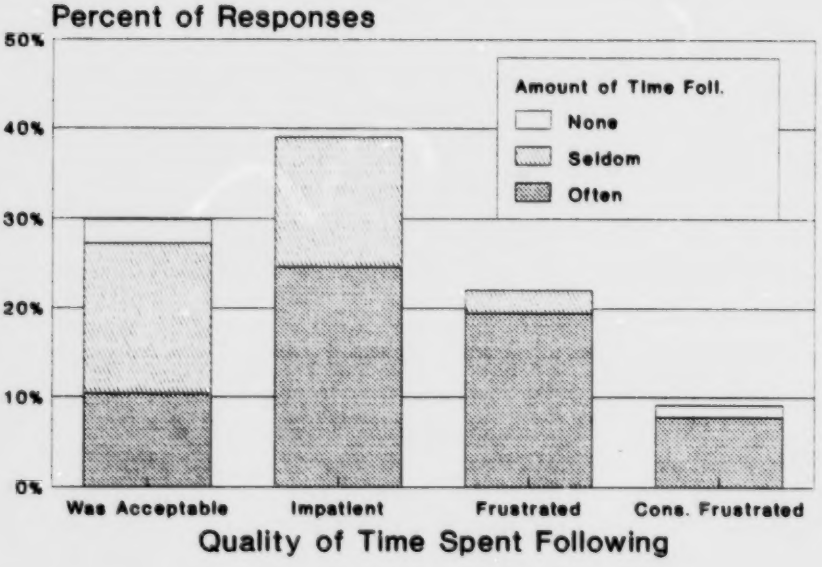
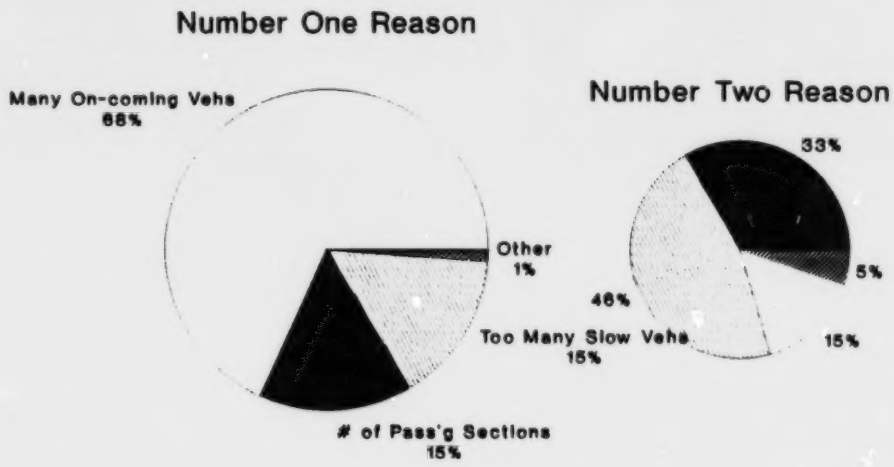


Figure 4.6
Quality of Time by Amount of Time



Truck drivers mostly indicated only one primary reason rather than ranking the options; the most outstanding was on-coming vehicles. The other two reasons were rated equally.

Figure 4.7
Question 4 - Inability to Pass



4.6 Safety of Highways

Question 6 asked the respondents to rate the safety of the highway. Figure 4.8 illustrates that the majority rated the highway safety as average. More importantly truck drivers, who are typically exposed to many highways mostly, rated the highway safety as average. Seventy seven percent of the truck or bus drivers rated the highway safe or average.

4.7 Helpfulness Of Signs

Question 8 was asked to determine whether the general public could understand and benefit from the signs guiding them through the passing lanes. Based on the results in Figure 4.9, 10 km and distance to the next passing lane signs are not necessary. Some respondents did indicate difficulty seeing the signs at times, that the printing is too small, and that the signs are difficult to

Figure 4.8
Safety of Highway

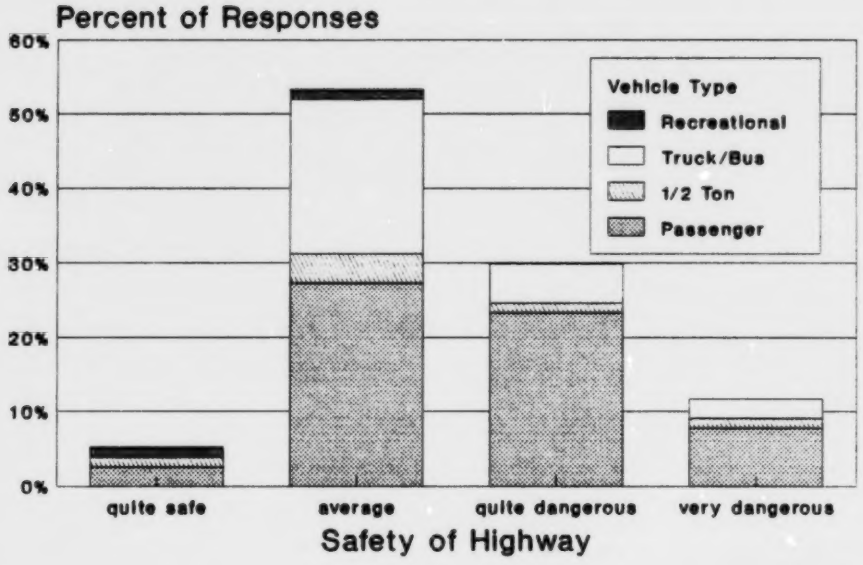
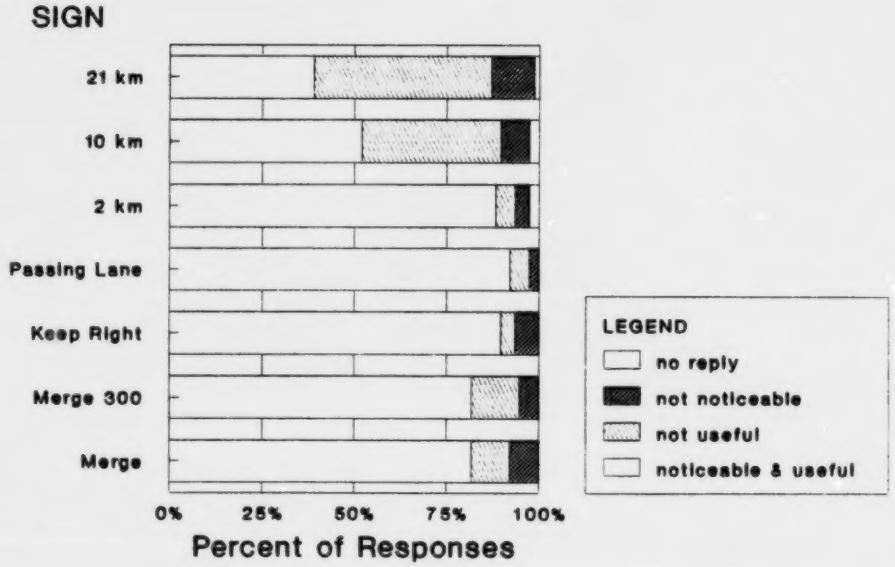


Figure 4. 9
Helpfulness of Signs

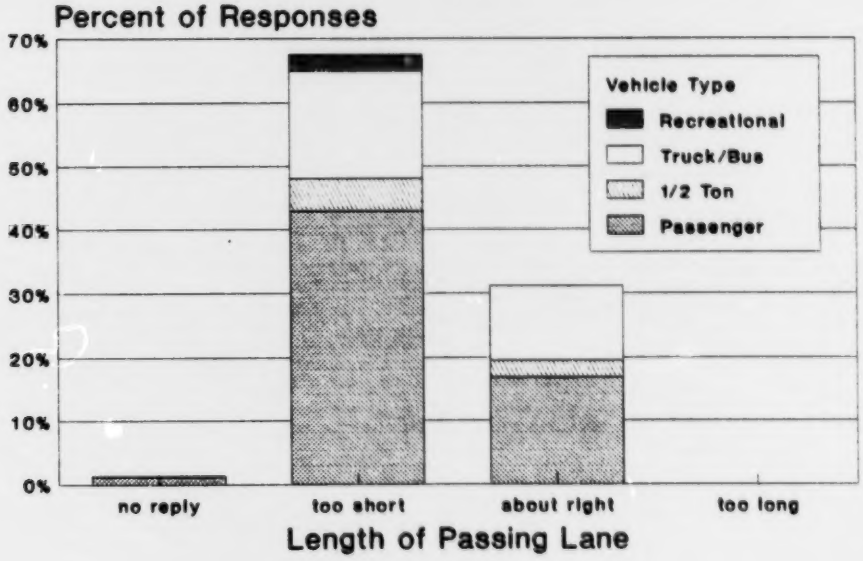


see at night. One person indicated the signs at the merge should be posted on the opposite side of the road. If a small vehicle is passing a truck near the merge, the merge signs are hidden by the truck. A summary of the comments is provided in Figure 4.11.

4.8 Length Of Passing Lanes

When asked if the passing lanes are long enough in Question 11, 67.5% of the respondents indicated the lanes are too short as illustrated in Figure 4.10.

Figure 4.10
Length of Passing Lane



4.9 Do Vehicles Keep Right

When asked to indicate whether vehicles generally keep right, 80.5% indicated yes and 11.7% indicated not always. Only 5% responded negatively to the question. This can be compared with the observations made in July in which 5.5% of the vehicles did not keep right when they should have. The responses are summarized in Figure 4.11.

Figure 4.11

RESPONSES TO QUESTION 9 - All Respondents

9. Are any of these signs difficult to understand? If so, indicate the corresponding letter shown above and comment.

		Responses
a.	no or no response	68
b.	No but hard to see at times. Put Signs on opposite side of road	1
c.	Printing too small	2
d.	Hard to see at night	1
e.	yes, no other comment	3
f.	Drivers don't pay attention to them	1
g.	Signs without descriptive explantions are confusing	1

RESPONSES TO QUESTION 10 - All Respondents

10. When you use the passing lanes do slower moving vehicles generally move to the right lane? (Comments)

		Responses
a.	yes	62
b.	Not always. A few slower vehicles stay in the passing lane	9
c.	Vehicles travel side by side for the entire passing lane	1
d.	Vehicles speed up when nearing the end of the passing lane	1
e.	Cars pass on the right lane	1
f.	Few vehicles move to the right	3

RESPONSES TO QUESTION 12 - All Respondents

12. When you use the passing lanes have you experienced any problems merging at the end of the passing lane? (Comments)

		Responses
a.	No or no response	43
b.	Vehicles speed up to pass others before passing lane ends	6
c.	Passing lane too short - not enough time to pass	5
d.	Vehs. not merging properly. Slow lane not allowed to merge	9
e.	Crowding and driving on shoulder at end of passing lane	8
f.	Only when traffic is heavy	2
g.	Passing lane ends on an upgrade (can't see oncoming vehicles)	2
h.	Sign not visible at end of passing lane	2

Figure 4.11

RESPONSES TO QUESTION 13 - All Respondents

13. Any additional comments or suggestions?

	Responses
a. no comment	25
b. Double lane all or this section, Hwy 1 in province, or in nation	21
c. Passing lane too short	3
d. Passing lane allows for good traffic flow	1
e. More passing lanes needed	11
f. Passing lanes should be on a level stretch, not an upgrade	2
g. Passing lane W. of Grenfell is too close to Jct Hwy 47	1
h. Separate the passing lanes	1
i. Need better road markings, increase shoulder widths	2
j. Speed limit not followed	1
k. Instruct slow vehicles to keep right at start of passing lane	1
l. Truck traffic too slow, too heavy to allow for safe passing	2
m. General comment not related to passing lanes	6

4.10 Merging Problems

Several people indicated in Question 12 that they had difficulty merging. Figure 4.11 illustrates that 37.7% of the respondents mentioned that vehicles speed up, vehicles are not merging properly, signs aren't visible at the end of the passing lane and that the passing lane ends on an up grade.

4.11 Additional Comments or Suggestions

Many respondents offered additional comments. This was the most appropriate way to determine how people feel about passing lanes because a direct question too easily preconditions a response. Twenty-seven per cent asked for double laning on Highway No. 1, either for the section or the whole nation. Fifteen percent commented positively regarding the passing lanes and 4% mentioned the passing lanes are too short. All of the comments are summarized in Figure 4.11. Other notable comments are that passing lanes should not be on an upgrade, the passing lanes should be separated and that the lanes are too close to the junction of Highway No. 47.

4.12 Other Feedback

Members of two local RCMP detachments were questioned by telephone regarding the passing lanes. They were generally pleased with the lanes and indicated that additional ones would be beneficial.

4.13 Conclusion

The 10 Km and distance to the next passing lane signs are useful to only 40% of the respondents. The passing lanes are perceived to be too short despite that over twice as many overtakings take place in the first half of the passing lanes compared with the last half. Signing at the merge ends could be improved by putting signs on both sides of the road to make them more visible. Vehicles generally do move to the right as designed. Twenty five percent of the respondents indicated problems with the actual merge maneuver even though few conflicts were observed. Fifteen percent of the respondents made positive comments regarding passing lanes. Twenty-five percent requested four laning.

5.0 OPERATIONAL SAFETY OF THE MERGE ENDS

5.1 Traffic Conflict Definitions

One of the methods used for studying the passing lanes was video taping the lane drop transition areas. Traffic operations were observed to identify whether any operational problems associated with the passing lane merge ends exists.

The merge lane study was conducted at the west passing lanes near the Town of Wolseley. East bound and West bound traffic was observed by video taping traffic operations at the merge end tapers. Evaluation of the merge ends was conducted by reviewing the video tapes for traffic conflicts and erratic maneuvers.

Similar research into conflicts and erratic maneuvers was completed by the Midwest Research Institute in December of 1985 (4). The definitions for the conflicts and erratic maneuvers were adopted from this research and are illustrated in Figure 5.1. Descriptions of these conflicts are in Appendix E.

A traffic conflict in the lane drop merge area is defined as a situation in which one of two or more vehicles is required to take evasive action (ie. to brake or swerve) to avoid another vehicle.

5.2 Traffic Conflict Data

Traffic conflicts occurred for 3.1% of all vehicles. The most common type of conflict was the lane change conflict occurring for 2.0% of all vehicles. The method of detecting this conflict, which is when a vehicle in the right lane merges into the left lane and this causes the other vehicle to brake, doesn't take into account normal braking unrelated to a conflict.

5.3 Classifications

Figure 5.2 illustrates the classification of vehicles involved in conflicts and encroachments and of all vehicles.

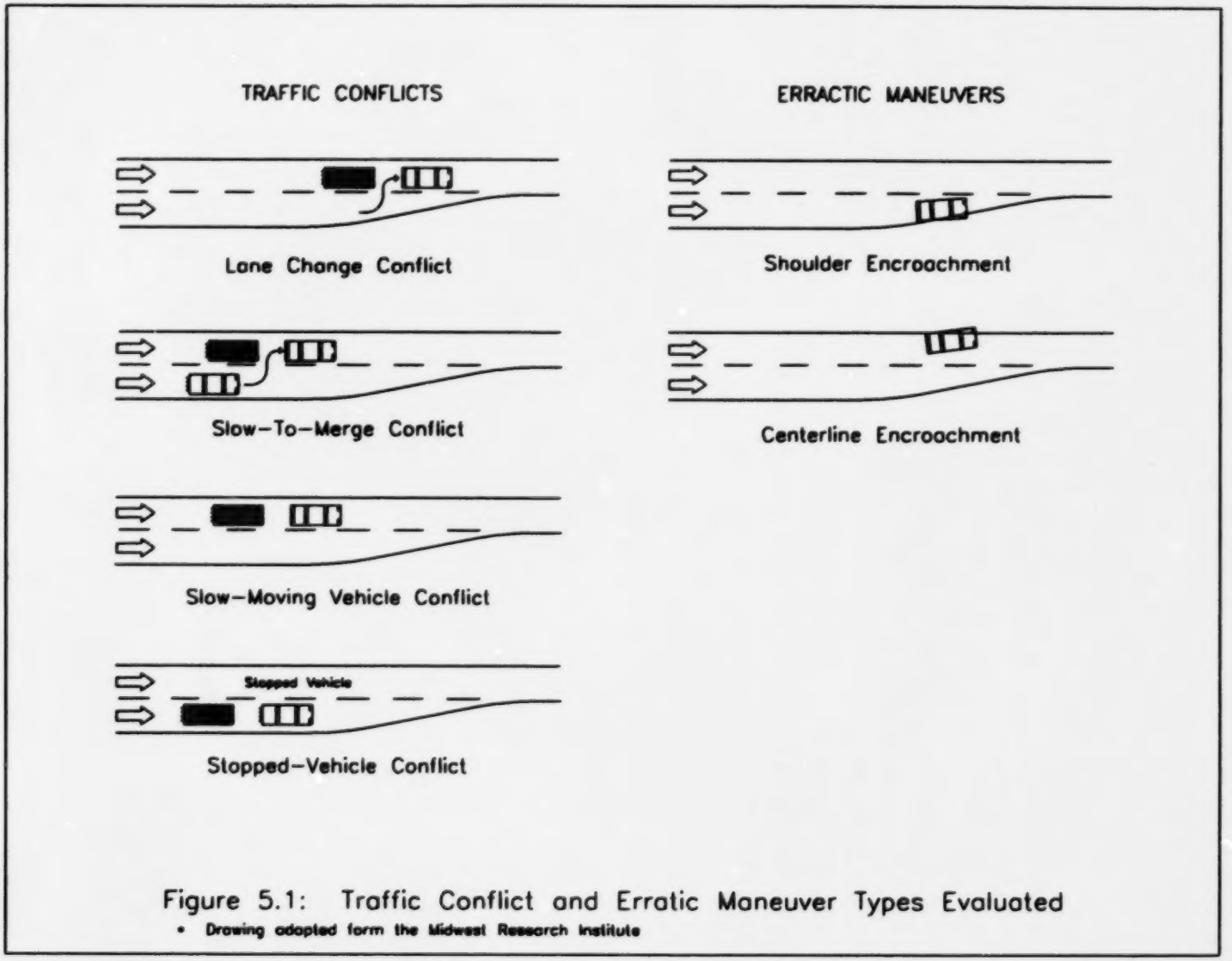
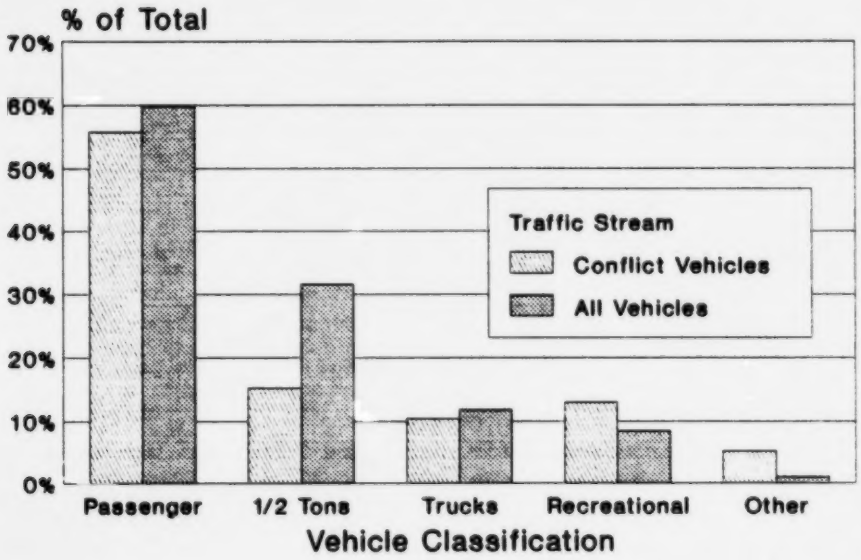


Figure 5.1: Traffic Conflict and Erratic Maneuver Types Evaluated

- Drawing adapted form the Midwest Research Institute

Recreational vehicles have a comparatively high conflict rate. They were involved in 13% of all conflicts while they comprised 8.5% of all traffic. This comparatively high conflict rate for recreational vehicles may be the result driver inexperience with the passing lane, driver inexperience with the recreational vehicle, limited visibility with the recreational vehicle, elderly drivers who have trouble shoulder checking because of limited visibility relative to younger drivers, and the slower speeds at which recreational vehicles travel relative to average speed.

Figure 5.2
Types of Vehicles in Conflicts



5.4 Merging problems

Review of the video tapes revealed that some drivers perceived that the right lane of the passing lane ends much more rapidly than it actually does. In a major conflict situation drivers are forced to remain on the shoulder of the highway. Once the conflict ends, the driver on the shoulder sometimes swerves erratically even though there is no danger of leaving the road surface. This indicates that the merge taper slope may need a slight adjustment so that the lane appears to end less abruptly.

Some confusion as to right-of-way exists at the merge end tapers. For example, many slower moving vehicles in the right lane were observed "cutting off" faster vehicles in the left lane, causing a traffic conflict. Quite often slow moving vehicles do not merge quickly enough or faster moving vehicles attempt a late pass and a traffic merge conflict results.

The observed vehicles seemed to have no problems travelling within the marked lanes except when a conflict situation arose and they were forced to swerve. The only notable problem is that the merge arrows are worn and cannot be seen by merging vehicles. Improved arrows may help vehicles to merge more quickly thus reducing the number of late merge attempts.

5.5 Conclusion

Traffic conflicts occurred for 3.12% of all vehicles travelling in one direction along the highway, mostly due to the merging vehicle causing a conflict for other vehicles. This rate is significantly higher than research by the Midwest Research Institute determined for similar merge taper lengths. No motor vehicle accidents at the passing lanes have reported in the eighteen months of their operation, contrary to the high conflict rate observed.

Many slower moving vehicles in the right lane were observed "cutting off" faster vehicles in the left lane, causing a traffic conflict. One possible reason for this merge end conflict, is driver inexperience in a passing lane situation. There needs to be some onus on the passing vehicle to allow the slower vehicle to merge back into the traffic stream.

6.0 SUMMARY OF CONCLUSIONS

Trans Canada Highway No. 1 from Grenfell to Indian Head is a two lane highway with a design hourly volume of 400 vehicles per hour. The two sets of passing lanes which opened along this section in 1988 are evaluated in this report. The following conclusions summarize the findings.

1. A larger proportion of heavy vehicles and recreational vehicles lead platoons relative to the number travelling on this section of highway. Platoon size is not a function of location relative to the passing lanes nor of classification of the platoon leaders.

2. The platooning in the passing lane drops by 35%, less than the expected 50% theoretical reduction. The net percent reduction achieved over the ten kilometre effective length is 14.5% for 300 vehicles per hour, and 20% for 500 vehicles per hour. For the passing lanes heading into the nearby towns the effective length is restrained to five kilometres.

3. More vehicles pass at the beginning of the passing lane which is expected of drivers who are prepared to pass knowing that the upcoming passing lanes will provide an assured passing opportunity. Ninety-five percent of the drivers use the passing lane properly by moving to the right. The number of vehicles not keeping right was greater towards the end of the passing lanes.

4. Sixty percent of the respondents of a passing lane questionnaire rated the highway as safe. The passing opportunities are perceived as fair by 45% of the respondents and 62% of the respondents often spend time following slower vehicles. Half of these are frustrated while doing so.

5. The 10 Km and distance to the next passing lane signs are useful to only 40% of the respondents. The passing lanes are perceived to be too short despite over twice as many overtakings take place in the first half of the passing lanes compared with the last half. Signing at the merge ends could be improved by putting signs on both sides of the road to make them more visible. Vehicles generally do move to the right as designed.

Twenty five percent of the respondents indicated problems with the actual merge maneuver even though few conflicts were observed. Fifteen percent of the respondents made positive comments regarding passing lanes. Twenty-five percent requested four laning.

6. Traffic conflicts occurred for 3.1% of all vehicles travelling in one direction along the highway, mostly due to the merging vehicle causing a conflict for other vehicles. This estimate is subject to the observers discretion whether a vehicle is braking because of a conflict or for other reasons. Many slower moving vehicles in the right lane were observed "cutting off" faster vehicles in the left lane, causing a traffic conflict. One possible reason for this merge end conflict, is driver inexperience in a passing lane situation.

6.1 Further Research Required

On four lane divided highways some platooning will naturally occur even at low traffic volumes. Additional research is required to determine what amount of platooning is acceptable by drivers.

Research is also required to determine how the conflicts at the merge tapers for passing lanes compare with conflicts for the transition from four to two lanes.

APPENDIX A

APPENDIX A DATA ACCURACY

TSR Accuracy

Traffic operations data was collected by using visual observations and automatic traffic statistics recorders (TSR). The study locations, data and method of data collection are listed in Table A.1. The accuracy of the TSR's is summarized in this section.

The Table A.2 compares the results of TSR counts with the visual counts. The TSR's are very accurate except in the passing lanes. Note that although the accuracy of the counts ranges from 0.4% to -12.3%, anything ± 10% is acceptable because some of the error is in timing the visual observation with the change in the interval for the TSR.

The limitations of the TSR's is that they would not accurately count vehicles in two separate lanes and as a result the data collection in the passing lanes is the apparent platooning, not the actual platooning. The visual data collected in the passing lanes does identify the lane each vehicle was travelling at one location, km 30.4.

A comparison between the apparent platooning at km 31.0 and the apparent platooning at km 30.4 indicates the TSR's collect this data quite accurately. Therefore, all the percent platooned data measured by the TSR's in the passing lanes will be reduced by two-thirds for one way volumes to estimate actual platooning. Table A.3 summarizes the change in platooning in the passing lane.

TABLE A.3

Westbound platooning from 13:30 to 15:00, July 18th, 1989

Km Location	% Platooned	Vehicles	Method
30.0	Out of Order		TSR
30.4 Right Lane	20.9	163	Visual
30.4 (apparent)	33.7%	208	Visual
31.0 (apparent)	31.8%	195	TSR
31.8 (apparent)	33.4%	207	TSR

Table A.1 1989 Study Locations

LIST OF MANUAL PASSING LANE STUDIES, C.S. 1-05

Location	Dir.	Date	Time	Type	Comments
km 10.0	wb	11-Jul	1:15	gap,class	
km 5.6	wb	11-Jul	11:05	gap,class	
km 3.7	eb	13-Jul	10:35	gap,class	
km 5.9	eb	13-Jul	12:45	gap,class	in passing lanes
km 31	wb	18-Jul	10:50	gap,plat leader	in passing lanes
km 31.8	wb	18-Jul	10:55	gap,plat leader	
km 30.4	wb	18-Jul	1:10	gap,plat leader, lane	
km 26.7	eb	20-Jul	11:35	gap,plat leader	
km 31.9	eb	20-Jul	2:05	gap,plat leader	
west lanes	eb	21-Jul	10:50	overtaking	last half p.lane
west lanes	eb	21-Jul	10:50	overtaking	first half p.lane
east lanes	eb	21-Jul	1:17	overtaking	first half p.lane
east lanes	eb	21-Jul	1:17	overtaking	last half p.lane

TSR DATA AVAILABLE - C.S. 1-05

KM Location	START Date	Time	END Date	Time	HOURS Missing
30.0, wb	Jul-17	8:30	Jul-19	8:00	2.5
31.0, wb	Jul-17	9:00	Jul-19	8:00	24
31.8, wb	Jul-17	9:30	Jul-19	8:00	0
32.5, wb	Jul-17	11:00	Jul-19	8:00	0
36.3, wb	Jul-17	11:00	Jul-19	8:00	7.5
38.6, wb	Jul-17	12:00	Jul-19	8:30	8
30.1, eb	Jul-19	11:30	Jul-21	9:00	15.5
31.9, eb	Jul-19	11:00	Jul-21	9:00	0
27.5, eb	Jul-19	13:00	Jul-21	9:30	0
28.7, eb	Jul-19	13:00	Jul-21	9:30	0
24.7, eb	Jul-19	13:30	Jul-21	9:30	0
26.7, eb	Jul-19	13:30	Jul-20	16:00	17
5.6, wb	Jul-10	11:30	Jul-12	8:30	0
7.2, wb	Jul-10	13:30	Jul-12	8:40	0
8.1, wb	Jul-10	13:50	Jul-12	8:50	0
10.0, wb	Jul-10	14:20	Jul-12	8:50	0
12.1, wb	Jul-10	volume only			
15.1, wb	Jul-10	15:20	Jul-12	9:10	0
5.1, eb	Jul-12	11:30	Jul-14	9:20	0
7.7, eb	Jul-12	10:40	Jul-14	9:10	0
5.9, eb	Jul-12	11:10	Jul-14	9:10	0
2.2, eb	Jul-12	13:40	Jul-14	8:40	0
3.1, eb	Jul-12	13:20	Jul-14	9:30	0
3.7, eb	Jul-12	12:40	Jul-14	9:20	0

Table A.2 TSR Accuracy

TRAFFIC COUNTER ACCURACY TESTS

		TIME		LOCATION		COUNTS			PLAT VEHICLES			% Platooned		
TSR	Date	Start	End	Km	Description	Man.	TSR	% Diff	Man.	TSR	% Diff	Man.	TSR	Diff
806	20-Jul	12:00	13:30	26.7	eb, dwnstrm	166	164	-1.2%	28	27	-3.6%	16.9	16.54	-0.3
802	20-Jul	14:30	16:00	31.9	eb, upstrm	205	192	-6.3%	43	51	18.6%	21.0	26.5	5.5
801	18-Jul	11:00	12:30	31.8	wb, pas.lane	191	178	-6.8%	60	49	-18.3%	31.4	27.5	-3.9
801	11-Jul	13:20	15:10	10.0	wb, dwnstrm	262	251	-4.2%	82	66	-19.5%	31.3	26.2	-5.1
420	11-Jul	11:10	13:00	5.6	wb, dwnstrm	276	277	0.4%	73	70	-4.1%	26.4	25.3	-1.1
423	13-Jul	10:40	12:30	3.7	eb, dwnstrm	260	251	-3.5%	52	44	-15.4%	20.0	17.5	-2.5
804	13-Jul	12:50	14:40	5.9	eb, pas.lane	232	219	-5.6%	60	51	-15.0%	25.9	23.3	-2.6
806	18-Jul	11:00	12:30	31.0	wb, pas.lane	195	171	-12.3%	69	53	-23.2%	35.4	31	-4.4
	18-Jul	13:30	15:00	30.4	wb, p.l. - both	208	#N/A		70	#N/A		33.7	#N/A	
	18-Jul	13:30	15:00	30.4	wb, p.l. - righ	163	#N/A		34	#N/A		20.9	#N/A	
420	18-Jul	13:30	15:00	30.0			out of order							
806	18-Jul	13:30	15:00	31.0	wb, pas.lane	#N/A	195		#N/A	62		#N/A	31.8	

TRARR Simulation

Initially TRARR was run to calibrate it to actual traffic operations data on Highway No. 1 with the passing lanes which was collected using the TSR's. The model is quite accurate for three out of four passing lanes. For the eastbound passing lanes near Wolseley the model overestimates platooning by 5%. The attached figures illustrate TRARR simulation versus actual data for various traffic volumes on all four highway sections.

The only before data available for a comparison of actual data versus simulated data was collected at km 27.0 and is provided in Table A.4.

Platooning Before Passing Lanes

TABLE A.4

Direction	Veh/hr	% Platooned
Eastbound	137	28%
Westbound	183	41%
Both	320	35%

The sample is not sufficient enough for a reasonable comparison.

FIG A.1 ACTUAL VS SIMULATED % PLATOONED
EAST PASSING LANES, EASTBOUND

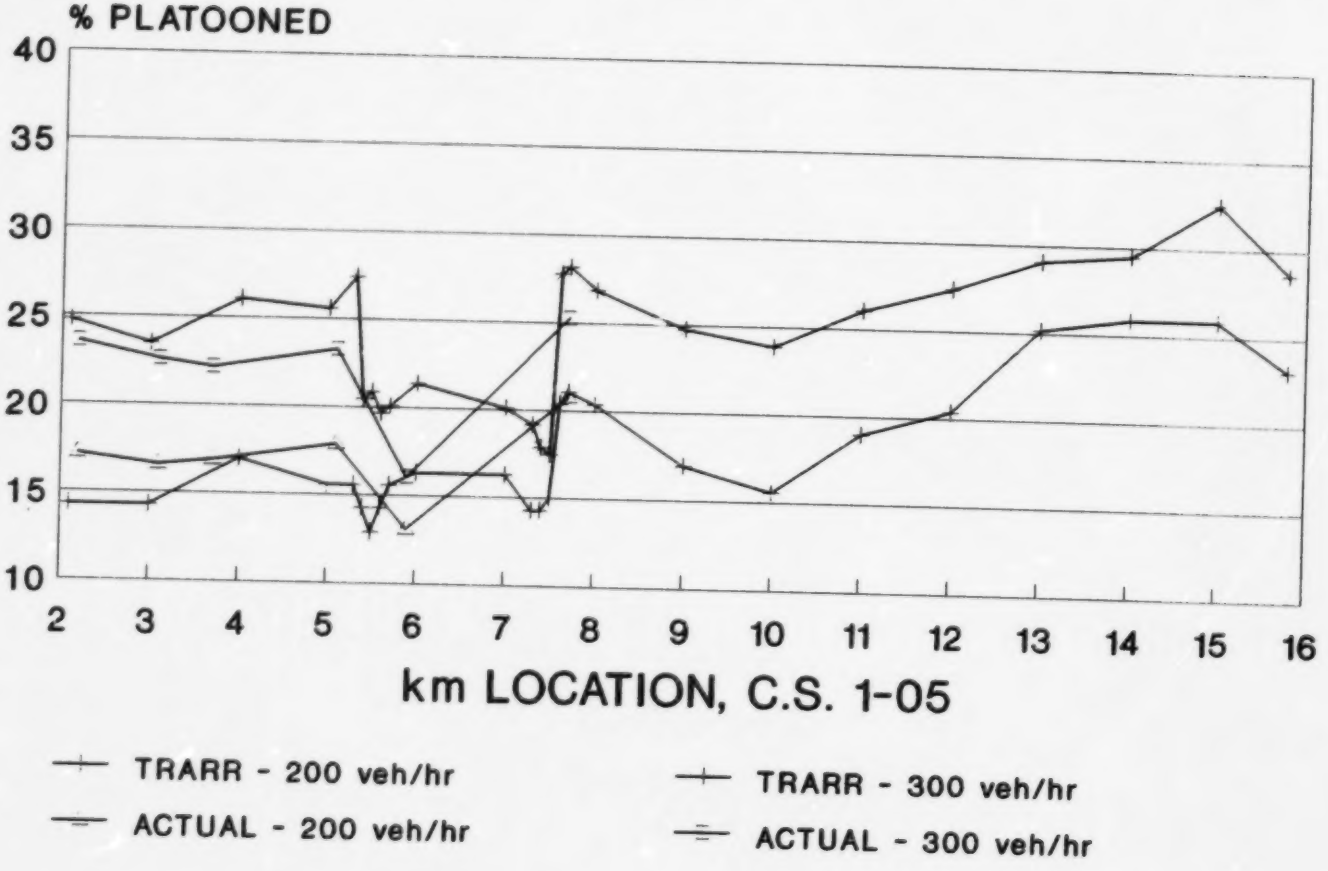


FIG A.2 ACTUAL VS SIMULATED % PLATOONED
EAST PASSING LANES, WESTBOUND

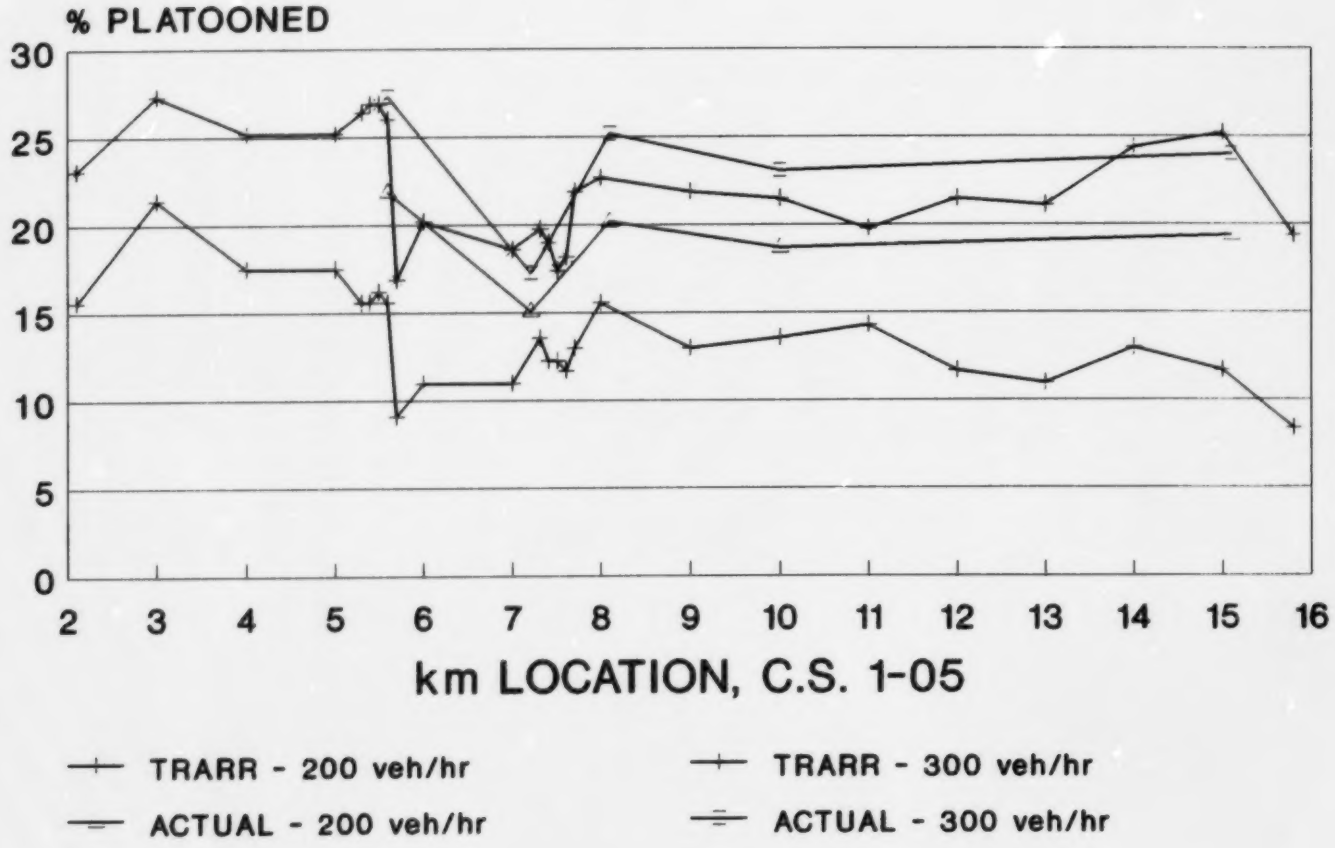


FIG A.3 ACTUAL VS SIMULATED % PLATOONED
WEST PASSING LANES, EASTBOUND

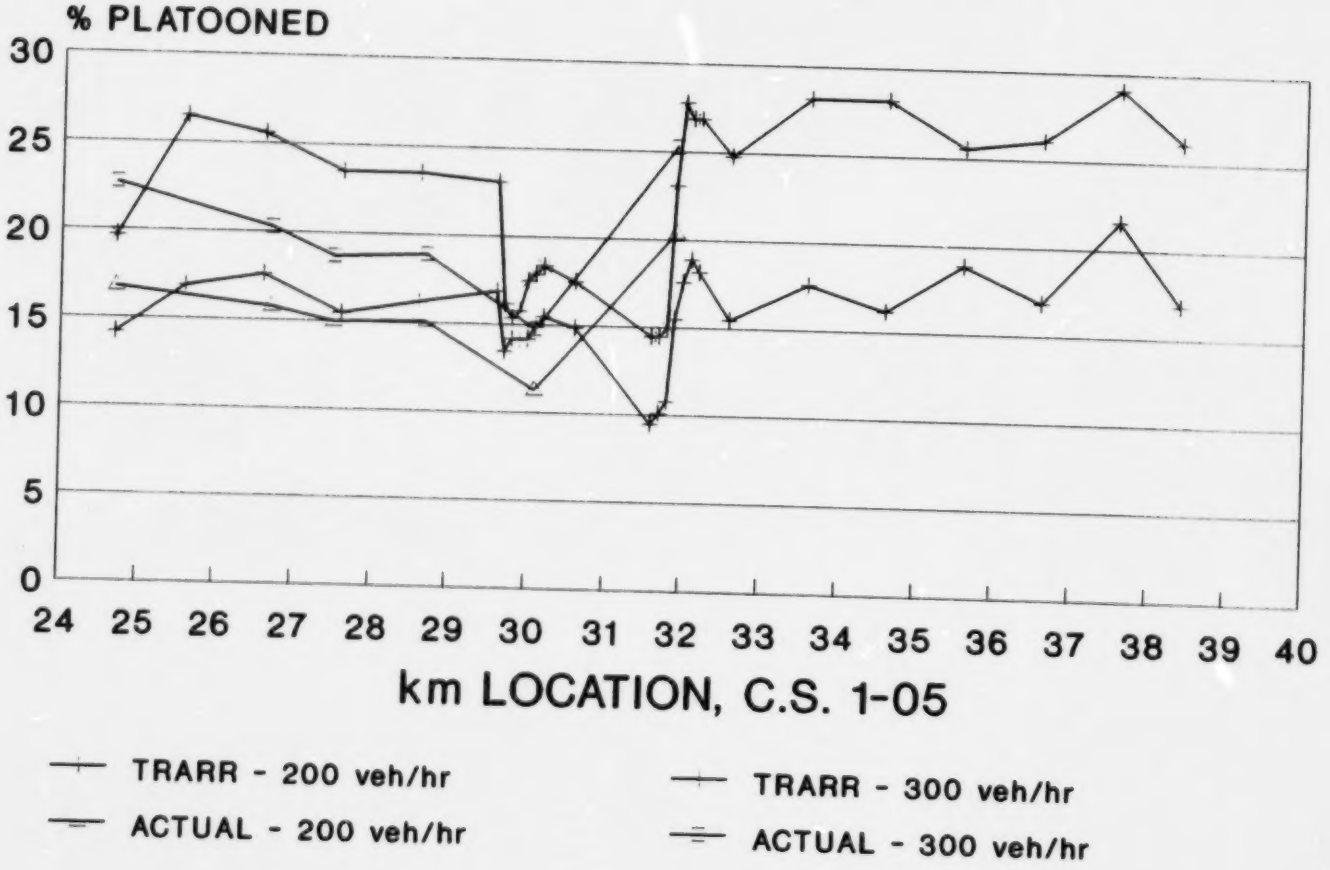
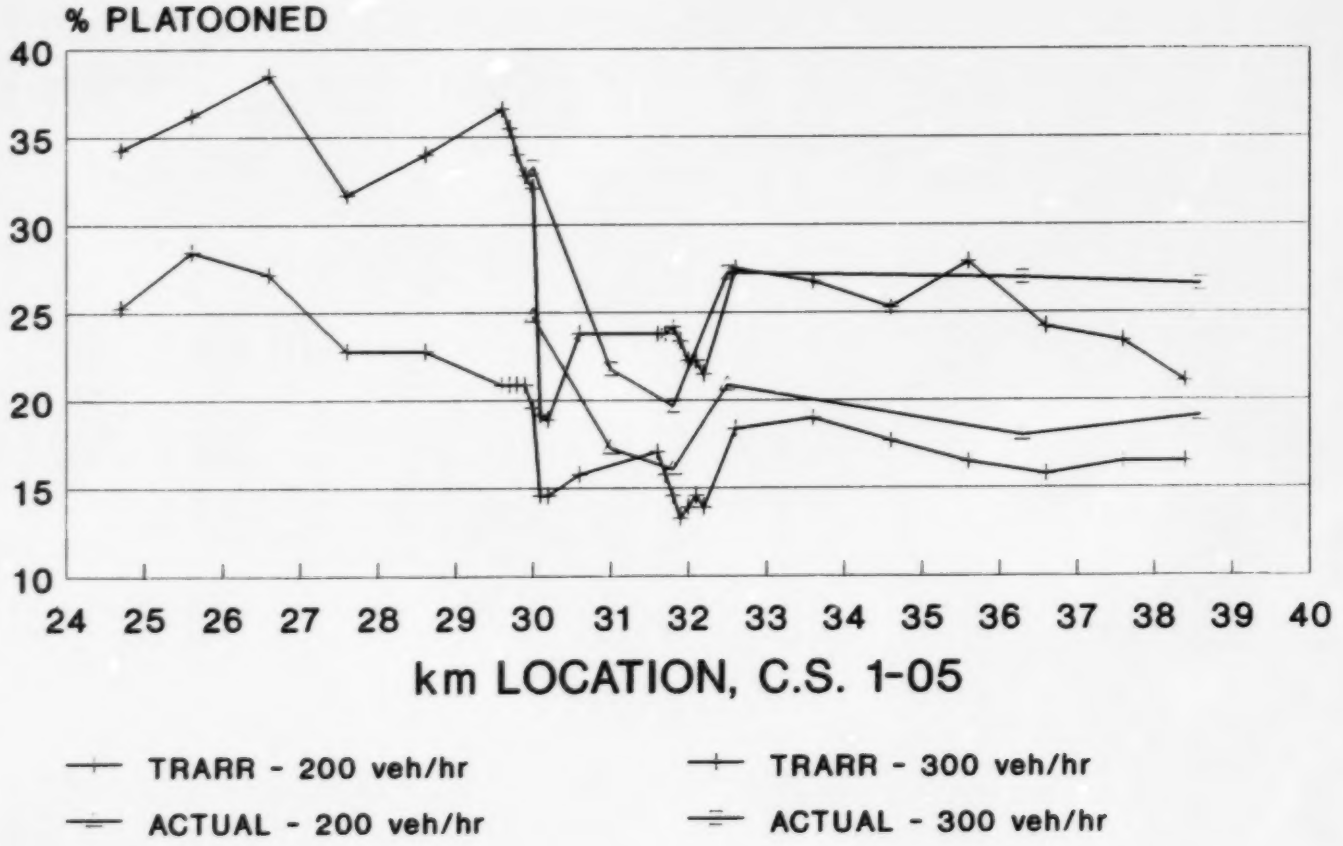


FIG A.4 ACTUAL VS SIMULATED % PLATOONED
WEST PASSING LANES, WESTBOUND



APPENDIX B

Table B.1 Vehicle Classifications

VEHICLE CLASSIFICATIONS
C.S. 1-05, km 3.7, 5.6 and 10.0
2 Hour Totals

All Vehicles

	vehicles	% of Total
car	475	58.0
car/tr	17	2.1
panel	60	7.3
panel/tr	8	1.0
1/2 ton	101	12.3
1/2 ton/tr	10	1.2
rec	31	3.8
rec/tr	7	0.9
misc	15	1.8
2 axle	19	2.3
3 axle	9	1.1
4 axle	3	0.4
5 axle	44	5.4
6 axle	3	0.4
7 axle	8	1.0
8 axle	9	1.1
Total	819	100
unknown	46	

Platoon Leaders

	vehicles	% of Total
car	73	51.0
car/tr	6	4.2
panel	8	5.6
panel/tr	1	0.7
1/2 ton	16	11.2
1/2 ton/tr	2	1.4
rec	9	6.3
rec/tr	1	0.7
misc	3	2.1
2 axle	3	2.1
3 axle	3	2.1
4 axle	0	0.0
5 axle	15	10.5
6 axle	0	0.0
7 axle	1	0.7
8 axle	2	1.4
Total	143	100
unknown	3	

TOTAL VEHICLES	865
Veh/hr/location	144
Platooned Vehicles	214
% platooned	24.7%

TABLE B.2 PLATOON SIZE BY LOCATION AND VEH TYPE

VEHICLE PLATOONING
C.S. 1-05, km 3.7, 5.6 and 10.0
2 Hour Totals

Platoon Leaders by Frequency of Platoon Size

	2 veh	3 veh	4 veh	6 veh	7 veh	Average Size
car	47	17	4	5	0	2.6
car/tr	5	1	0	0	0	2.2
panel	7	1	0	0	0	2.1
panel/tr	1	0	0	0	0	2.0
1/2 ton	11	4	1	0	0	2.4
1/2 ton/tr	1	1	0	0	0	2.5
rec	9	0	0	0	0	2.0
rec/tr	1	0	0	0	0	2.0
misc	3	0	0	0	0	2.0
2 axle	2	1	0	0	0	2.3
3 axle	2	1	0	0	0	2.3
4 axle	0	0	0	0	0	0.0
5 axle	10	3	2	0	0	2.5
6 axle	0	0	0	0	0	0.0
7 axle	0	0	0	0	1	7.0
8 axle	2	0	0	0	0	2.0
TOTAL	101	29	7	5	1	2.5
unknown	3	0	0	0	0	2.0
	146					

Frequency of Platoon Size by Location

Location	Platoon Size					Total
	2 veh	3 veh	4 veh	6 veh	7 veh	
km 3.7, eb	34	10	1	0	0	45
km 5.6, wb	36	5	3	4	0	48
km 10.0, wb	34	14	3	1	1	53
TOTAL	70	15	4	4	0	146
% of TOT	47.9%	10.3%	2.7%	2.7%	0.0%	

Platooning by Location

	km Location			
	3.7	5.6	10.0	ALL
% Platooned	20.1	24.9	29.2	24.7
Plat Vehs	57	75	82	214
Vehicles	283	301	281	865
Avg Plat Size	2.26	2.56	2.55	2.47

TABLE B.3 % PLATOONED BY VOLUME

ACTUAL AVERAGE PLATOONING VERSUS TWO-WAY TRAFFIC VOLUME
Collected by Traffic Statistics Recorders

	% PLATOONED					
	ACTUAL			ADJUSTED		
Veh/hr	100	200	300	100	200	300
km LOCATION						
westbound						
5.6	13.3	21.9	27.3			
7.2	11.8	22.6	26	7.9	15.1	17.3
8.1	9.4	20.2	25.2			
10	10.1	18.7	23.1			
15.1	8.4	19.4	NA			
eastbound						
7.7	10.3	20.8	25.3			
5.9	11.1	19.7	24.2	7.4	13.1	16.1
5.1	11.7	17.9	23.3			
3.7	8.4	16.9	22.2			
3.1	10.5	16.6	22.6			
2.2	9.6	17.2	23.6			
westbound						
30	12.7	24.8	33.3			
31	10	26	32.7	6.7	17.3	21.8
31.8	12.9	24.2	29.6	8.6	16.1	19.7
32.5	10.5	20.9	27.3			
36.3	9.3	18	27			
38.6	9.2	19.1	26.6			
eastbound						
31.9	7.8	20.4	25.3			
30.1	10.6	17	22.2	7.1	11.3	14.8
28.7	7.4	15.1	18.9			
27.5	7	15	18.7			
26.7	8.9	15.8	20.3			
24.7	11.9	16.8	22.7			
	10.1217	19.3478	24.8818			

APPENDIX C

RECOMMENDED:

DIRECTOR DESIGN & TRAFFIC SAFETY

APPROVED:

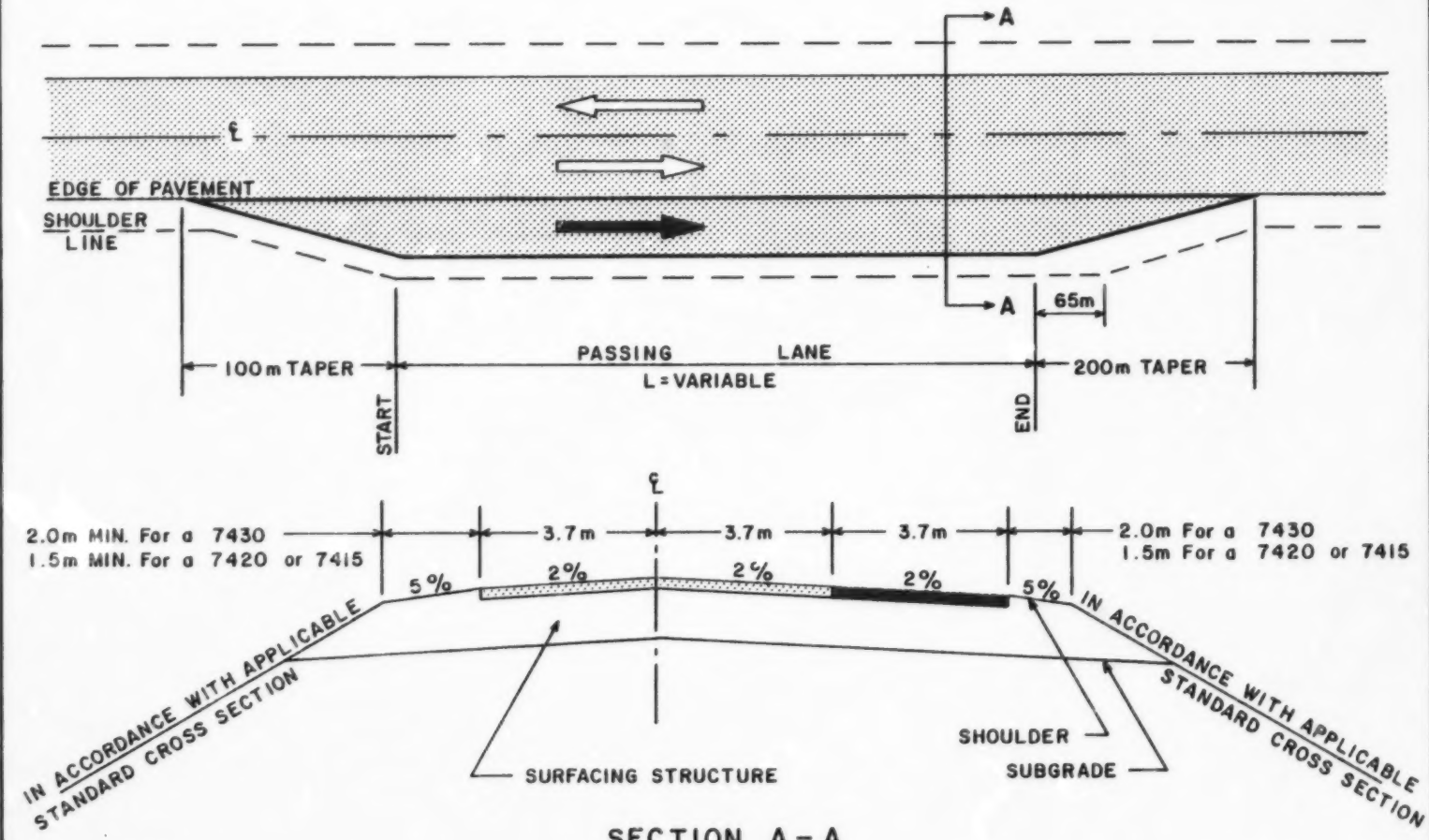
EXECUTIVE DIRECTOR (ENGINEERING)

DATE:

SASKATCHEWAN DEPARTMENT OF HIGHWAYS AND TRANSPORTATION

PASSING LANE LAYOUT

STANDARD PLAN No.



SECTION A – A

NOTES 1. DETAILED LOCATION AND LAYOUT TO BE APPROVED BY EXECUTIVE DIRECTOR, ENGINEERING DIVISION.
2 TAPER LENGTHS ON HORIZONTAL CURVES TO BE MODIFIED IN ACCORDANCE WITH S.P. No. 20622.
3 LAYOUT ILLUSTRATES LANE IN ONE DIRECTION ONLY. FOR OVERLAPPING OR SIDE BY SIDE LANES, CORRESPONDING DIMENSIONS APPLY TO THE ALTERNATE DIRECTION.

1985 HCM:TWO-LANE HIGHWAYS

****

FACILITY LOCATION.... Trans Canada Highway Saskatchewan
ANALYST..... John Morrall
TIME OF ANALYSIS..... 12/3/90
DATE OF ANALYSIS..... 12/3/90
OTHER INFORMATION....

A) ADJUSTMENT FACTORS

PERCENTAGE OF TRUCKS.....	13
PERCENTAGE OF BUSES.....	0
PERCENTAGE OF RECREATIONAL VEHICLES.....	9
DESIGN SPEED (MPH).....	70
PEAK HOUR FACTOR.....	1
DIRECTIONAL DISTRIBUTION (UP/DOWN).....	50 / 50
LANE WIDTH (FT).....	12
USABLE SHOULDER WIDTH (AVG. WIDTH IN FT.)...	6
PERCENT NO PASSING ZONES.....	35

B) CORRECTION FACTORS

LEVEL TERRAIN

LOS	E T	E B	E R	f w	f d	f HV
A	2	1.8	2.2	1	1	.81
B	2.2	2	2.5	1	1	.77
C	2.2	2	2.5	1	1	.77
D	2	1.6	1.6	1	1	.84
E	2	1.6	1.6	1	1	.84

C) LEVEL OF SERVICE RESULTS

INPUT VOLUME(vph): 400
ACTUAL FLOW RATE: 400

LOS	SERVICE FLOW RATE	V/C
A	204	.09
B	455	.21
C	781	.36
D	1419	.6
E	2365	1

LOS FOR GIVEN CONDITIONS: B

1985 HCM:TWO-LANE HIGHWAYS
****

FACILITY LOCATION.... Trans Canada Highway Saskatchewan
ANALYST..... John Morrall
TIME OF ANALYSIS..... 12/3/90
DATE OF ANALYSIS..... 12/3/90
OTHER INFORMATION....

A) ADJUSTMENT FACTORS

PERCENTAGE OF TRUCKS.....	13
PERCENTAGE OF BUSES.....	0
PERCENTAGE OF RECREATIONAL VEHICLES.....	9
DESIGN SPEED (MPH).....	70
PEAK HOUR FACTOR.....	1
DIRECTIONAL DISTRIBUTION (UP/DOWN).....	50 / 50
LANE WIDTH (FT).....	12
USABLE SHOULDER WIDTH (AVG. WIDTH IN FT.)...	6
PERCENT NO PASSING ZONES.....	35

B) CORRECTION FACTORS

LEVEL TERRAIN

LOS	E T	E B	E R	f w	f d	f HV
A	2	1.8	2.2	1	1	.81
B	2.2	2	2.5	1	1	.77
C	2.2	2	2.5	1	1	.77
D	2	1.6	1.6	1	1	.84
E	2	1.6	1.6	1	1	.84

C) LEVEL OF SERVICE RESULTS

INPUT VOLUME(vph): 500
ACTUAL FLOW RATE: 500

LOS	SERVICE FLOW RATE	V/C
A	204	.09
B	455	.21
C	781	.36
D	1419	.6
E	2365	1

LOS FOR GIVEN CONDITIONS: C

SASKATCHEWAN HIGHWAYS AND TRANSPORTATION
AUTOMATIC TRAFFIC RECORDER SYSTEM
HIGHEST HOUR & DAY CALCULATION

ATR 0022

HIGHEST HOUR CALCULATION

RANK	COUNT	DAY	DATE	HOUR	
1	469	MONDAY	SEPTEMBER 04, 1989	15	HOLIDAY
2	463	SUNDAY	AUGUST 06, 1989	14	
3	462	MONDAY	OCTOBER 09, 1989	16	HOLIDAY
4	437	MONDAY	SEPTEMBER 04, 1989	13	HOLIDAY
5	434	SUNDAY	AUGUST 06, 1989	13	
6	424	MONDAY	SEPTEMBER 04, 1989	14	HOLIDAY
7	408	MONDAY	OCTOBER 09, 1989	15	HOLIDAY
8	406	SUNDAY	AUGUST 06, 1989	16	
9	403	SUNDAY	AUGUST 06, 1989	17	
10	401	SUNDAY	AUGUST 06, 1989	15	
11	400	FRIDAY	MARCH 24, 1989	11	HOLIDAY
12	397	SUNDAY	JULY 02, 1989	15	
13	396	SUNDAY	JULY 02, 1989	14	
14	388	MONDAY	OCTOBER 09, 1989	17	HOLIDAY
15	382	THURSDAY	AUGUST 03, 1989	14	
16	381	MONDAY	OCTOBER 09, 1989	14	HOLIDAY
17	377	THURSDAY	AUGUST 03, 1989	11	
18	376	MONDAY	SEPTEMBER 04, 1989	16	HOLIDAY
19	373	SUNDAY	JULY 23, 1989	11	
20	365	THURSDAY	AUGUST 03, 1989	15	
21	363	MONDAY	SEPTEMBER 04, 1989	12	HOLIDAY
22	360	FRIDAY	MARCH 24, 1989	12	HOLIDAY
23	360	THURSDAY	JUNE 29, 1989	15	
24	360	THURSDAY	JUNE 29, 1989	16	
25	360	MONDAY	SEPTEMBER 04, 1989	17	HOLIDAY
26	359	SUNDAY	JULY 02, 1989	17	
27	358	THURSDAY	JUNE 29, 1989	14	
28	358	THURSDAY	AUGUST 03, 1989	17	
29	357	SUNDAY	AUGUST 06, 1989	11	
30	356	FRIDAY	AUGUST 04, 1989	11	
40	343	SUNDAY	JULY 02, 1989	16	
50	332	THURSDAY	JUNE 29, 1989	18	
60	326	SATURDAY	AUGUST 12, 1989	15	
70	321	SATURDAY	AUGUST 19, 1989	14	
80	315	THURSDAY	JULY 06, 1989	15	
90	310	FRIDAY	JUNE 30, 1989	11	
100	306	SATURDAY	JULY 08, 1989	13	

HIGHEST DAY CALCULATION

COUNT	DAY	DATE	
5318	THURSDAY	AUGUST 03, 1989	
5093	THURSDAY	JUNE 29, 1989	
5093	SUNDAY	AUGUST 06, 1989	
4708	SUNDAY	JULY 02, 1989	
4665	FRIDAY	SEPTEMBER 01, 1989	
4642	MONDAY	SEPTEMBER 04, 1989	HOLIDAY
4553	FRIDAY	OCTOBER 06, 1989	
4391	THURSDAY	JULY 20, 1989	
4373	THURSDAY	JULY 13, 1989	
4276	THURSDAY	JULY 06, 1989	
4262	THURSDAY	JULY 27, 1989	
4223	MONDAY	OCTOBER 09, 1989	HOLIDAY
4183	WEDNESDAY	AUGUST 02, 1989	
4155	THURSDAY	AUGUST 10, 1989	
4150	SATURDAY	JULY 08, 1989	
4139	THURSDAY	AUGUST 17, 1989	
4134	SUNDAY	JULY 23, 1989	
4108	FRIDAY	AUGUST 04, 1989	
4100	SATURDAY	JULY 01, 1989	HOLIDAY
4066	SATURDAY	JULY 29, 1989	
4061	SATURDAY	AUGUST 12, 1989	
4061	THURSDAY	AUGUST 24, 1989	
4019	FRIDAY	MAY 19, 1989	
3987	SATURDAY	JULY 22, 1989	
3979	SATURDAY	JULY 15, 1989	
3969	THURSDAY	MARCH 23, 1989	
3967	FRIDAY	DECEMBER 23, 1988	
3908	FRIDAY	JULY 28, 1989	
3889	FRIDAY	JUNE 30, 1989	
3822	WEDNESDAY	JUNE 28, 1989	
3698	WEDNESDAY	JULY 26, 1989	
3552	THURSDAY	AUGUST 31, 1989	
3436	MONDAY	AUGUST 07, 1989	HOLIDAY
3319	MONDAY	JULY 10, 1989	
3107	FRIDAY	JUNE 09, 1989	
2972	SUNDAY	JUNE 11, 1989	
2864	SUNDAY	APRIL 02, 1989	

APPENDIX D

Driver Attitude Survey on the Quality of Service
on the Trans-Canada Highway

The purpose of this survey is to obtain your observations about the quality of service on the Trans-Canada Highway between Whitewood and Indian Head.

Your response will be used to help determine engineering solutions to improve traffic flow on two-lane highways. Thank you for your co-operation.

Please return the attached questionnaire to:

Design and Traffic Safety Branch
9th Floor, 1855 Victoria Avenue
Regina, Saskatchewan
S4P 3V5

1. What type of vehicle do you normally drive on this section of highway?

   Passenger Vehicle _____

   Half-ton _____

   Truck (specify # of axles) _____

   Bus _____

   Recreational Vehicle (specify type) _____

   Other _____

2. How would you rate the opportunities to pass other vehicles on the road?

   very poor _____

   fair _____

   good _____

   excellent _____

3. How much time do you spend following slower vehicles along this section of highway?

   none at all _____

   seldom _____

   often _____

4. If you had to follow slow moving vehicles, rank (1 for the main reason) the following three causes for inability to pass:

limited number of highway sections marked for passing _____

too many slow moving vehicles in front to pass safely _____

too many on-coming vehicles _____

other (please state) _____

5. The time you spent following vehicles: (check one)

was acceptable _____

made you impatient _____

made you frustrated _____

made you considerably frustrated _____

6. Rate the safety of this section of highway between Whitewood and Indian Head. (check one)

quite safe _____

average _____

quite dangerous _____

very dangerous _____

7. When using the Trans-Canada Highway between the Whitewood and Indian Head do you recall the two sets of passing lanes near Grenfell and Wolseley.

Yes ____

No ____

If your answer is No, disregard further questions.

8. How helpful are the following signs for your driving experience. Check one for each sign.

a)

noticeable and useful _____
noticeable and not useful _____
not noticeable _____

b)

noticeable and useful _____
noticeable and not useful _____
not noticeable _____

c)

noticeable and useful _____
noticeable and not useful _____
not noticeable _____

d)

noticeable and useful _____
noticeable and not useful _____
not noticeable _____

e)

noticeable and useful _____
noticeable and not useful _____
not noticeable _____

f)

noticeable and useful _____

noticeable and not useful _____

not noticeable _____

g)

noticeable and useful _____

noticeable and not useful _____

not noticeable _____

9. Are any of these signs difficult to understand? If so, indicate the corresponding letter shown above and comment.

_____

_____

_____

10. When you use the passing lanes do slower moving vehicles generally move to the right lane? (Comments) _____

_____

_____

_____

_____

11. Is the length of the passing lane

too short _____

about right _____

too long _____

12. When you use the passing lanes have you experienced any problems merging at the end of the passing lane? (Comments)

_____

_____

_____

_____

_____

13. Any additional comments or suggestions?

_____

_____

_____

_____

_____

Appendix D

QUESTIONNAIRE RESULTS

			Rank							Sign											
#	type	passing	follow	A	B	C	D	time	safety	recall	A	B	C	D	E	F	G	dif	right	length	merge	comment
1	1	1	3	3	2	1		4	3	1	3	2	1	1	1	2	2	1	1	1	1	1
2	1	2	3	3	2	1		2	3	1	1	1	1	1	1	1	1	1	2	1	2	
3	3	1	1			1		4	2	1	1	1	1	1	1	2	2	2	2	1	3	2
4	1	1	3	3	1	2		4	4	1	3	3	3	3	3	3	3	3	2	1	4	1
5	2	1	3			1		3	2	1	1	1	1	1	1	1	1	1	1	1	4	3
6	5	1	2	3	1	2		2	2	1	2	1	1	1	1	1	1	1	2	1	4	1
7	1	3	3			1		2	3	1	2	2	1	2	2	1	1	1	3	1	5	4
8	1	3	2			1		3	2	1	1	1	1	1	1	2	1	1	2	1	4	5
9	5	3	1				1	1	1	1	1	1	1	1	2	1	1		2	1	4	6
10	4	2	3	1	1	1		2	2		2	2	1	1	1	1	1	1	2	1	4	
11	1	2	3	1	3	2		3	3	1	2	1	1	1	1	1	1	1	2	1	4	3
12	1	1	3			1		2	3	1	2	2		1	1	1	1	1	4	1	4	1
13	3	1	3	1	2	3		4	3	1	2	2	1	1	1	1	1		2	2		7
14	3	2	1	3	2	1		1	2	1	2	1	1	1	1	1	1	1	2	1	3	1
15	3	2	2	1		3	2	2	2	1	1	1	1	1	1	1	1	1	2	1	3	8
16	3	2	3			1		3	3	1	2	2	1	1	1	3	3	4	2	1	4	9
17	3	2	2	2	3	1		1	2	1	2	2	1	1	1	1	1	1	2	1	1	4
18	3	2	2		2	1	3	2	2	1	3	3	1	1	3	3	3		1	1	5	2
19	1	2	3	2	1	3		2	2	1	1	1	1	1	1	1	1	1	1	2	4	10
20	1	2	3	2	3	1		2	3	1	1	1	1	1	1	1	1	1	2	1	4	
21	2	2	3			1		2	2	1	3	3	3	2	1	1	1		2	1	5	11
22	1	1	3			1		2	3	1	1	1	1	1	1	1	1	1	2	2	4	
23	3	1	2	1				3	3	1	1	1	1	1	1	1	1	3	2	1	3	
24	3	2	2		1			2	2	1	2	2	1	1	1	1	1		2	2		
25	3	3	3					1	2	1	1	1	1	1	1	1	1	1	1	2	4	12
26	3	2	3		1	1		1	2	1	1	1	1	1	1	1	1	1	2	2	4	
27	1	1	3		1	1		3	4	1	2	2	2	2	1	2	3		2	1	5	13
28	1	1	3	2	3	1		2	3	1	2	2	1	1	1	1	1	1	2	1	2	4
29	1	1	3	1	1	1		3	4	1	1	1	1	1	1	1	1	1	2	1	3	3
30	1	1	3		2	1	2	2	3	1	2	1	1	1	1	1	1	1	5	2	1	14
31	1	2	3	2	3	1		1	2	1	1	1	1	1	1	1	1	1	2	2	4	9
32	2	1	3	3	2	1		2	4	1	2	2	1	1	1	1	1	1	6	2	6	3
33	1	2	2			1		2	2	1	3	3	1	1	1	3	3		2	2	5	

QUESTIONNAIRE RESULTS

				Rank							Sign											
#	type	passing	follow	A	B	C	D	time	safety	recall	A	B	C	D	E	F	G	dif	right	length	merge	comment
34	3	1	2			1		2	4	1	2	1	1	1	1	1	1		2	1	3	15
35	3	2	3	2	3	1		1	2	1	2	1	1	1	1	1	1	1	2	2	3	10
36	1	3	2	3	2	1		1	2	1	1	1	1	1	3	1	1	1	1	1	2	10
37	1	1	3	1		1		2	4	1	2	2	1	1	1	1	1	1	2	1	4	10
38	1	2	3			1		3	3	1	2	2	2	1	1	2	2		2	1		
39	1	2	3	1				1	2	1	3	2	2	1	3	2	1	5	2	1	4	
40	1	2	2			1		2	2	1	2	1	1	1	1	1	1		1	1	7	
41	1	3	2		1			1	1	1	2	2	1	1	1	1	1		2	1	4	16
42	1	1	3	3	2	1		3	3	1	2	2	1	1	1	1	1		2	1	7	3
43	3	1	3		1			4	4	1	2	2	2	2	2	2	2	6	2	1	3	14
44	3	2	2			1		1	2	1	1	1	1	1	1	1	1		2	2	4	
45	2	3	3			1		1	1	1	1	1	1	1	1	1	1		2	1	4	10
46	1	1	3	2	3	1		4	3	1	1	1	1	1	1	2	2	5	2	1	4	13
47	1	3	2			1		1	2	1	2	2	1	1	1	1	1	1	2	2	4	
48	1	3	2	3	2	1		2	2	1	2	1	1	1	1	1	2	1	2	1	1	
49	3	2	2			1		1	2	1	1	2	1	1	1	1	1	1	2	2	6	
50	3	2	2	3	2	1		1	2	1	1	1	1	1	1	1	1	1	2	2	4	
51	1	1	3			1		3	3	1	3	3	3	3	3	1	1		2	1	4	17
52	6	2	3	3	2	1		3	2	1	1	1	1	1	1	1	1	1	2	2	5	18
53	1	2	2	3	2	1		1	2	1	2	2	1	1	1	1	1		2	1	4	
54	1	3	2	3	2	1		1	2	1	1	1	1	1	1	1	1		6	2	4	10
55	2	2	2	3	2	1		2	2	1	2	2	1	1	1	1	1		2	2	4	3
56	1	1	3			1		2	3	1	3	2	1	1	1	1	1	1	2	1	4	3
57	1	2	3			1		3	1	1	2	2	1	1	1	1	1	1	2	1	4	19
58	4	2	3	1	3	2		2	2	1	2	1	1	1	1	1	1		2	1	2	10
59	6	2	3	2	3	1		1	2	1	2	2	1	1	1	1	1	1	2	2	4	
60	1	1	3	2	3	1		2	4	1	1	1	1	1	1	1	1	5	2	1	1	14
61	1	1	3	3	2	1		3	3	1	2	2	1	1	1	1	1	1	6	1	4	
62	2	2	2	3	2	1		2	3	1	2	1	1	1	1	1	1	1	1	1	5	14
63	1	2	3	2	3	1		3	3	1	2	2	1	1	1	1	1	1	2	1	4	20
64	1	1	3	3	2	1		3	3	1	2	2	1	1	1	1	1	1	2	1	4	3
65	1	1	3	2	3	1		4	4	1	2	2	1	1	1	1	3		2	1	8	
66	1	1	3		1			2	2	1	1	1	1	1	1	1	1		2		8	3

Appendix D

QUESTIONNAIRE RESULTS

				Rank							Sign											
#	type	passing	follow	A	B	C	D	time	safety	recall	A	B	C	D	E	F	G	dif	right	length	merge	comment
67	1	2	2			1		2	2	1	1	1	1	1	1	1	1	1	2	1	4	
68	1	3	2	1				1	2	1			1	1	1	1	1	1	2	2	4	
69	1	3	2			1		1	2	1	1			1	1	2	2	1	2	1	4	
70	1	2	3			1		2	2	1	2	1	1	1	1	1	1	1	2	1	1	
71	1	2	2			1	1	1	2	1	2	2	1	1	1	1	1		2	1	3	
72	1	3	3	2	3	1		1	2	1	2	1	1	1	1	1	1		2	2	4	3
73	4	2	3		1	1		3	3	1	1	1	1	1	1	1	1	1	1	1	5	10
74	3	2	2	1	3	2		1	2	1	1	1	1	1	1	1	1	1	2	1	4	10
75	1	2	3	2	1	3		2	2	1	1	1	1	1	1	1	1	1	2	2	4	10
76	1	2	3	1	3	2	4	2	3	1	1	1	1	1	1	2	2	7	2	2	2	21
77	3	1	3			1		3	2	1	3	3	1	1	1	1	1		2	2	4	10

APPENDIX E

APPENDIX E Operational Safety - Conflict Definitions

Four types of traffic conflicts were evaluated in this study. A **lane-change conflict** is a situation in which the merging vehicle changes lanes, causing the passing vehicle to swerve or brake to avoid a collision. A **slow-to-merge** conflict occurs when a vehicle in the merge lane brakes before changing lanes causing the passing vehicle to brake or swerve to avoid a collision. A slow-moving vehicle conflict occurs when a vehicle brakes or swerves to avoid a slower moving vehicle in front of it. A **stopped-vehicle conflict** is a situation in which a vehicle brakes or swerves to avoid a stationary vehicle.

Erratic maneuvers are defined as unusual driving actions by a single free moving vehicle. The two types of maneuvers observed for vehicles in the merge ends of the passing lanes were **centerline encroachments** and **shoulder encroachments**.